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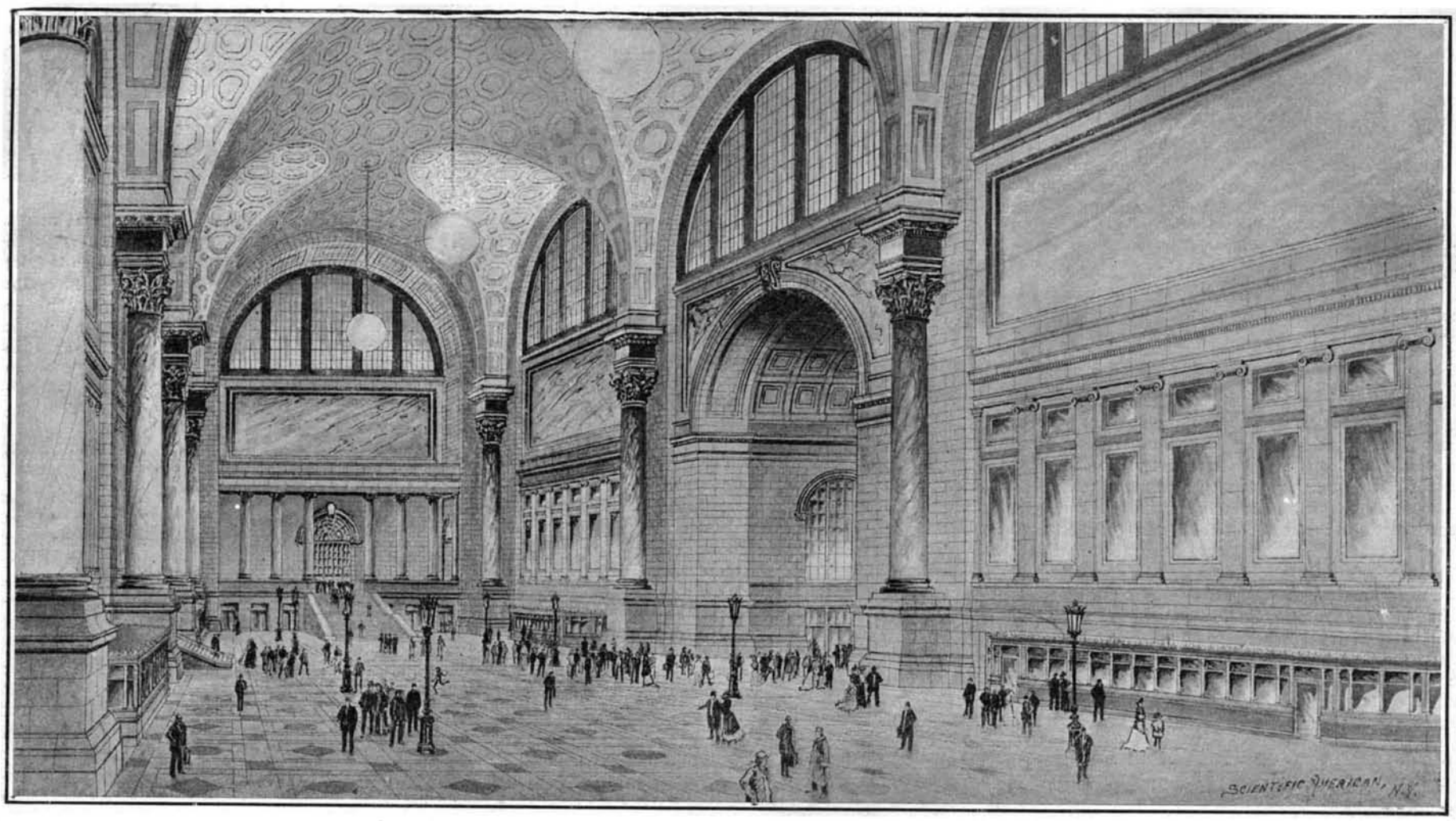
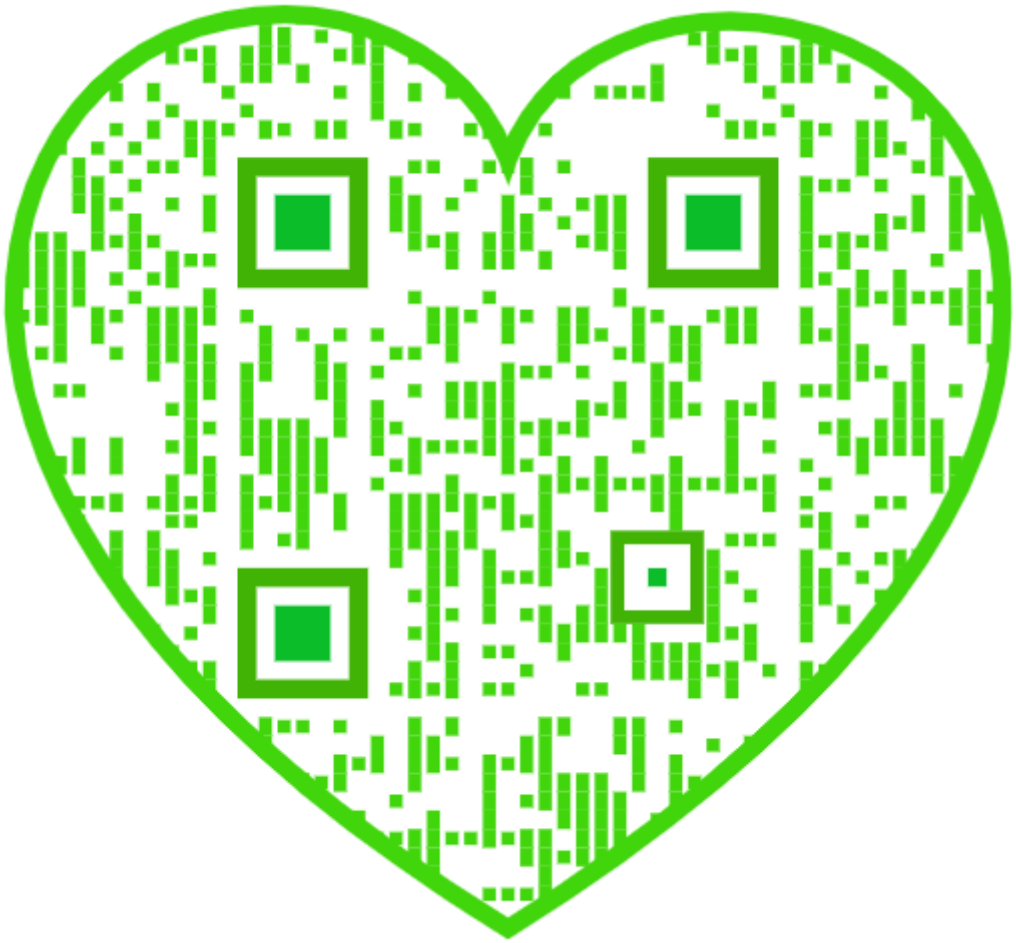
Bird's Eye View of Station From the Northeast as It Will Appear When Completed.



The General Waiting Room, 110 Feet Wide, 320 Feet Long, 150 Feet High.

THE NEW PENNSYLVANIA RAILROAD STATION, NEW YORK CITY.—I.—[See page 438.]



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NEW YORK, SATURDAY, MAY 26, 1906.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

CONDITIONS OF THE RAPID TRANSIT TUNNEL.

It has been rumored for many months that considerable difficulty was being experienced, during the driving of the Rapid Transit tunnel below the East River from the Battery, Manhattan, to Joralemon Street, Brooklyn, in preserving the tunnel at the predetermined grade. It is a fact that, as now constructed, a considerable portion of the tunnel, about fifteen hundred feet in all, on the Brooklyn side varies from the re-established grade by amounts that increase from a few inches to twelve inches, the variations consisting in a series of depressions or hollows in the grade, giving the latter something of a wave-line profile. Also, in this section of the tunnel, the cast-iron lining has cracked longitudinally, chiefly at the top, and sometimes at the bottom. The effect of the latter mishap has been to throw the cast-iron lining from a true circle into an ellipse, the lateral axis being greater than the vertical axis by varying amounts which reach, in the worst places, a maximum of six inches. That is to say, each side of the shell is in places as much as three inches outside of its true position, while the top and bottom are each three inches inside the true line.

It is claimed by the Rapid Transit engineers that the result is due to the difficult nature of the material at this part of the river bottom, and also to the usual methods employed by the contractor in driving the tunnel, methods which were not suited to the particular character of material through which he was working. The contractor, on the other hand, claims that the tunnel cast-iron lining, or shell, was not designed of sufficient strength to withstand the distortion stresses to which it is subjected, and that it was bound to crack and get out of line in the way that has happened. On the other hand, the engineers claim that where the contractor's methods were suited to the material through which the tunnel was driven, no trouble was experienced, that portion of the completed tunnel standing up to its work in satisfactory shape.

The effect of the depressions in the grade is that there is not sufficient clearance at these points to permit the cars to pass through without touching the roof of the tunnel. The matter is being remedied by taking out those sections of the floor which are too high to accommodate the re-established grade, and to a less extent sections of the roof are also being taken out. In each case new segments are being built in place, and the tunnel everywhere throughout the defective 1,500 feet is being restored to its proper internal diameter. It might be supposed that, when the sections of the floor were taken up, the sand would flow into the tunnel; but this is prevented by the air pressure which already exists for the regular driving process. For the roof repairs, which are of considerably less extent than those of the floor, the material above the roof is frozen before the plates are removed, the rigidity thus imparted to the overlying material serving, with the internal air pressure, to hold up the sand until the new roof has been put in place.

We wish to contradict the impression which has gone abroad as the result of the Mayor's statements at the last meeting of the Rapid Transit Commission, that these repairs are likely to entail either any delay in the completion of the work, or any increased expense to the city. The Rapid Transit Commission has held back $200,000 due upon this work, to cover the expenses of renewal, and the repairs are being carried on simultaneously with the driving of the 1,000 feet of tunnel which remains to be completed before a junction is effected below the center of the East River. It is confidently expected by the engineers that the tunnel will be completed by the end of the year, and that the first cars will be run through early in January next.

It should be explained that the difficulty in keeping a subaqueous tunnel of this character to true line and level is not by any means peculiar to this work under the East River. The same problems were experienced in the tunnels that have been driven below the North River, where the tube not only showed a tendency to get out of line, but was so distorted by the pressures to which it was subjected, that it was necessary to resort to a system of internal tie rods in order to hold it to circular form. Moreover, there need be no apprehension as to the future stability and safety of the East River tunnel. Although it might have been advisable to make the shell heavier, it is reinforced by concrete on the inside and by grouting on the outside, until the total thickness of the combined iron and concrete is on an average about twelve inches. After the work has been concreted and grouted up in this way, the material of the river bottom has no tendency to produce any further displacement or distortion of the tunnel.

EFFICIENCY OF THE AMERICAN LOCOMOTIVE.

It is not likely that another series of locomotive tests as elaborate as those which have recently been published by the Pennsylvania Railroad Company, will be undertaken for some time to come. The plant was of the most modern pattern, and expense was not considered in providing every form of apparatus that could conduce to the accuracy of the results. Moreover, no less than forty engineers, skilled in investigations of this character, were continuously employed on the work. A summary of the conclusions, recently published, proves that the American locomotive, at least in some of its forms, is efficient and economical to a degree that was not generally supposed; and the fact that it has shown its ability to produce a horse-power for the consumption of 2 pounds of coal per hour brings it almost into line with the average of modern stationary steam engines. In the first place, it was found, contrary to common belief, that the large modern boilers with which locomotives have been supplied, evaporate as much steam per square foot of heating surface, even when forced to maximum power, as the smaller boilers. Most of the boilers tested delivered 12 pounds of steam per square foot of heating surface per hour, and one of the largest boilers delivered as high as 16.3 pounds. It was found in all the boilers that a high quality of steam was produced, and that the greatest evaporative efficiency was shown when the power developed was the least. When they were running under conditions of maximum efficiency, most of the boilers evaporated between 10 and 12 pounds of water per pound of dry coal. There was a gradual fall of efficiency as the rate of evaporation increased, which was, of course, to be expected, until, when the boilers were being pushed to the limit, the efficiency fell to between 8 and 6 pounds of water per pound of dry coal.

When the fuel was being burned at a low rate, the temperature of the firebox was found to be between 1,400 and 2,000 deg. F. The temperature increased slowly with the increase in the rate of combustion, the maximum observed firebox temperatures being between 2,100 and 2,300 deg. F. The smokebox temperature when the boilers were being worked at moderate power was about 500 deg. F. for all of the boilers. It increased gradually as the boiler was forced, until in the locomotives under test it reached from 600 to 700 deg. F.

On the important question of grate area it was proved that the boilers which have the largest ratio of grate surface to heating surface, have the greatest capacity. There was found to be but little loss of heat through imperfect combustion, always excepting the amount of fuel that was drawn off through the stack unburned, in solid particles. There seems to be no advantage in increasing firebox heating surface beyond a certain ratio in proportion to tube surface, the latter being capable of absorbing such heat as is not absorbed by the firebox surface. The draft in the front end, when the locomotive is running under low power, does not exceed about 1 inch of water, but it increases rapidly as the boiler is pushed, until maximum pressures of from 5 inches to as high as 8.8 inches are reached.

The indicated horse-power, shown in these tests, reached a maximum of 1,100 in the simple freight locomotive, and in the compound passenger locomotive it exceeded 1,600 horse-power. The steam consumption per indicated horse-power showed for a simple freight locomotive an average minimum of 23.7, the consumption, of course, depending upon speed and cut-off.

Compounding has again fully vindicated the theories upon which it is based, the compound locomotive consuming from 18.6 to 27 pounds of saturated steam per indicated horse-power per hour. When superheated steam was used, the minimum consumption was reduced to 16.6 pounds. The fact was brought out, furthermore, that while the steam consumption decreases with increase of speed in the simple locomotive, in the compound locomotive it increases, a condition which experience with the compound had led us to expect. Experiments with the throttle and cut-off proved that the locomotive performance is best, when carrying the same load, if a full throttle and a short cut-off is used.

A greater proportion of the cylinder power appears as pull in the drawbar at low speeds than at high speeds. Thus it was found that at 40 revolutions per minute, the maximum percentage at the drawbar is 94 and the minimum 77; whereas at 280 revolutions per minute the percentages fell to 87 maximum and 62 minimum. It was found, furthermore, that the loss of power between cylinder and drawbar depends largely upon the character of the lubricant, the substitution of grease for oil on the axles and crank-pins increasing the friction from 75 to 100 per cent.

Coal consumption per dynamometer horse-power hour in a simple freight locomotive was found at low speeds to vary from 3.5 to 4.5 pounds. For the compound freight locomotive tested under similar conditions, the consumption fell to between 2 and 3.7 pounds. The two-cylinder compound, run at high speed, showed a consumption of 3.2 to 3.6 pounds per dynamometer horse-power hour; while for the four compound passenger locomotives it varied, according to running conditions, from 2.2 to over 5 pounds per hour. In all of the locomotives the consumption increased rapidly with the speed.

Finally, it was proved, in a comparison of the compound freight with the simple freight locomotive, that the economy of the former is greatly superior. Under similar conditions the least economical compound shows a saving in fuel over the most economical simple locomotive of about 10 per cent, while the best compound showed a saving over the poorest simple locomotive of nearly 40 per cent. It is only fair to state that the conditions of the trials, which provided for continuous operation of the locomotives at constant speed and load, were all favorable to the compound. We are pleased to note that these valuable tests are now being continued at Altoona, where the plant has been placed in its permanent location.

DIRECTED WIRELESS TELEGRAPH MESSAGES.

The transmission and reception of two or more wireless telegraph messages simultaneously in the same zone of action, or selectively, as it is called, is a problem second only in its abstruseness to the telephonic relay, that scientific will-o'-the-wisp over which inventors have struggled ever since Bell devised his apparatus to send and receive articulate speech over wires.

Many solutions, electrical, mechanical, and electromechanical, have been provided to secure selectivity, but at the end of a decade of wireless telegraphy it seems that all the labor expended in this direction has been virtually in vain, in so far as the coveted goal is concerned, though through the researches in electrical resonance excellent results have been achieved in tuning and syntonization, which important factors are largely accountable for the present degree of advancement in long-distance wireless signaling.

Since it is sometimes more convenient to enter a window than to go through a door, many inventors have ceased trying, at least for the time, to discover the "open sesame" of selectivity, and have confined their efforts to the easier task of directing, within certain limits, the wireless waves. Artom, of Italy, was the first to evolve such an arrangement and attain favorable results; this he did by means of circularly polarized electrical radiations*, which he produced without resorting to reflection grids, as is necessary in the case of light waves.

Much simpler than this Italian physicist's method is one recently made public by Marconi, while the experiments of the latter indicate that a wider range of usefulness will be given the previously inflexible wireless transmitter and receptor than has yet been known. Briefly, the scheme is this: When one end of an insulated horizontal wire (the other end of which is free) is connected to one side of a spark gap of an induction coil, and the other side of the gap is earthed, the electric waves emitted by the wire will reach a maximum in the vertical plane of the horizontal wire, and proceed principally from the end connected to the spark gap, the radiation being imperceptible in any other direction approximating 100 deg. from that in which the maximum effect takes place.

Similarly, if an insulated conductor is laid on the ground, or placed a short distance above it, and the end nearest the sending station is connected to one side of an electric wave detector, the other side of which is earthed—leaving the opposite terminal of the wire free—the maximum effect will be evident only when the receiving and transmitting wires are in alignment with each other. Marconi further points out that if the receiving horizontal wire is so arranged that it can be turned in a circle about its earthed end in a horizontal plane, the maximum and minimum effects observed during the process of swiveling will enable an operator to easily determine the direction of any transmitting station within the field of radiation.

A number of trials were conducted to ascertain the best lengths of the horizontal wires for both transmission and reception, the distance these wires should be elevated from the earth, and finally the greatest distance obtainable between stations thus equipped. The experiments were further varied by

* Editorial Scientific American, October 7, 1905.

employing the regulation aerial wire for sending, the complementary apparatus using the horizontal wire.

The whole series of tests cannot here be cited in detail, yet the following will suffice to show in a measure the results secured. In one of the experiments the transmitter, having a spark length of about 2 cm. (¾ inch), was connected to a horizontal conductor 656 feet in length, supported at a height of 49¼ feet above the ground; the receptor was furnished with a wire of equal length 3¼ feet above the ground, and connected to one end of a magnetic receptor. Now, when the horizontal wires of both stations were in line, so that the maximum effects were obtainable, easily-read signals were heard at a distance of 25 km. (15½ miles). When the receiving wire was swung around to 12 deg., nothing could be heard even when the receptor was moved to within 12 km. (7½ miles) of the transmitter; and when placed within 5 km. (3.1 miles), the angles of the wires remaining unchanged, only weak signals were indicated.

In another trial the great Poldhu station with its vertical aerial was used for sending, and a receptor placed at Clifden, Ireland, 500 km. (310 miles) away, was provided with a horizontal conductor 754.6 feet in length, laid on the ground, and connected to one side of a magnetic receptor, the opposite side being grounded as previously explained. When the free end of the receiving wire pointed directly away from Poldhu, the signals were sharp and loud; but when the horizontal wire made an angle of more than 35 deg. with the line of Poldhu, the reception was absolutely *nil*.

In all of his experiments where the tests were made over considerable distances, Marconi employed his magnetic receptor; but where the distances were short, he utilized a Duddell thermo-galvanometer, since this delicate instrument permitted him to measure the current values of the electric oscillations set up in the receiving wires.

The horizontal wire, if it is proven to be anywhere nearly as effective as the usual aerial wire, will greatly reduce the expense of wireless telegraph installations, for the masts often cost as much or more than the instruments. The new arrangement will do much to further the commercial possibilities of this mode of transmitting intelligence if the mast can be eliminated, and the whole series of tests points to a new era of wireless telegraphy.

One of the noteworthy observations made by Marconi was that electric currents set up by distant atmospheric conditions can not only be detected, but the direction whence they originate determined; and this may mean that a new instrument is to be placed in the hands of the meteorologist. There are other aspects of the experiments which will be looked forward to with interest.

In the army and navy wireless telegraphy has proven an invaluable aid, and this has been due chiefly to the fact that messages could be sent and received over long distances, while the direction whence they came or whither they went was an impenetrable mystery to the enemy. Now all this is changed, and some extraordinary complications may be looked for. As a palpable problem it is a duplication of heavier armor plate, heavier guns; heavier guns, heavier armor plate, and so on to infinity.

THE MANUFACTURE OF TURPENTINE.

Turpentine or spirits of turpentine—to the old pharmacists everything volatile was a "spirit," thus "spirits of wine," alcohol—is a product of several varieties of pine tree, and the turpentines from the different species vary in their composition and properties. But in this country, or in the eastern three-fourths of it at least, we know but one kind, that produced from the yellow or long-leaf pine (*Pinus sylvestris*) of our southern seaboard and Gulf States.

When an incision is made through the bark of one of these trees at a season when the sap is flowing, a thick, clear, gummy juice exudes, and on exposure to the air gradually hardens into a friable but somewhat sticky mass. The odor of this juice, which in the trade is known as *gum thus*, or "virgin turpentine," is the characteristic turpentine smell, and its hardening is due to the evaporation of its contained turpentine, leaving behind its constituent gum resin or "rosin."

Formerly vast sections of all the States south of the Virginias and the Ohio and east of the Mississippi River were covered with immense forests of yellow pine, and during more than half a century these forests have been the chief source of supply for the turpentine and rosin consumed by the entire civilized world, with the exception of France, Russia, and eastern Europe, which are to some extent producers of turpentine for home consumption.

The effect of this immense drain upon our natural resources, coupled with primitive and criminally wasteful methods of production, has been to reduce the acreage of the pine forests from apparently exhaustless resources to a comparatively limited territory. A quarter of a century ago the principal center of the naval stores business ("naval stores" including turpentine, rosins, pitch and pine tree tar) was Wilmington, N. C. Later it gradually shifted to Charleston, S. C.; for a decade or more it remained at Savannah, Ga.; but during the past five years the Florida ports of Pensacola and Jacksonville have been slowly taking precedence. At the present time the "turpentine belt" is confined to the Gulf States. Though all the available territory in the adjoining States has not been exhausted, the end is plainly in sight unless the devastation can be checked.

The reason for this deplorable condition will be understood from a brief description of the methods commonly pursued by "turpentine farmers" in collecting the "crop."

The turpentine season opens in the early spring, when the sap begins to rise in the trees, and continues until late in the fall, when cold weather puts an end to the return flow. The turpentine farmer goes into the forest and selects a space containing the number of trees he proposes to work, and leases from the owner the acreage desired. Hiring the requisite number of negroes, he sets them to work "boxing" the trees. A few feet above the ground a shallow "box" or excavation is cut into the tree trunk, and above this box for some distance the bark is removed and the sap wood scarified. Often a second similar "box" is cut on the opposite side of the tree. The sap gradually exudes from the scarred surface or "face" and collects in the boxes, from which it is dipped out from time to time and collected at a central point. When the flow ceases or becomes sluggish, the face of the cut is scraped and rescarified to prevent the healing of the wound. During successive seasons the cuts are deepened and extended in height, until the tree dies from exhaustion or is blown over by a storm because of the weakening of the trunk.

Meanwhile, at some convenient central point in the "orchard," a crude still has been erected for the treatment of the collected sap. Into this still or series of stills the sap is charged, and live steam being passed through it, the turpentine passes over with the steam through a condensing "worm," and is collected as it drips from the condenser. The residue in the still is rosin, which after remelting and straining to remove twigs, leaves, and other impurities, is run while fluid into large rough wooden casks made on the spot. The sap from the first year's boxing produces the so-called "pale grades" of rosin, known in the trade as "water white" or "W. W.," "window glass" or "W. G.," "N.," "M," and "K" rosins. As the age of the "box" increases, the grade or color of the rosin deteriorates through the letters of the alphabet up to "D," "C," and "A" rosins, constituting the darkest and cheapest grades. This, roughly speaking, is the cause of the classification, though other influences help to determine the color and grade of the product.

Tar is made by a crude process of distillation applied to pine chips, twigs, etc., by direct heat, and is merely an occasional incident in the industry.

The product, both "spirits" and rosin, is sold largely to neighboring grocers and country storekeepers, either in exchange for supplies or for cash, and is by them shipped from time to time to the central markets, the principal "naval stores ports" being, in addition to those already named, Mobile, New Orleans, and Tampa. New York is also an important market, but the receipts at that port are all reshipments from southern ports.

From the foregoing outline of the methods pursued by the pine-forest devastators, with the added element of carelessness as to fires, it will be easily understood how the area of the long-leaf pine has in fifty years been reduced from millions of acres to hundreds of thousands. The government, through its Department of Agriculture, has lately intervened with an attempt to introduce more economical methods, by means of a simple device which is not only more efficient and cheaper than the old practice, but calculated to maintain the yield of sap indefinitely; but until the strict supervision of France, which enforces the replacement of the destroyed trees by new ones, is introduced, the extinction of our pine forests will be merely delayed, not averted.

Combinations of producers and factors or merchants have had some effect upon prices in recent years; but no combination, however effective, in an industry so widespread as this, could have raised the price of a product from an average level of from 25 to 35 cents to the present current prices for turpentine, which ranged in the past year from 55¾ cents to 79 cents per gallon; or of the pale rosins from an average of under $3 to $5 and $6; and of the low grades from a high limit of $1.50 to $3 or $4 or over. The end of American turpentine and rosins is in sight unless the waste be promptly checked.

The chief use of turpentine is in paints and varnishes, where it is employed as a volatile thinning agent. It evaporates very quickly, leaving no residue. It has the peculiar property of forming ozone, which is practically a condensed form of oxygen, and as oxygen is the cause of the drying of paints and varnishes, turpentine to this extent serves a double purpose. Its rate of evaporation also is slower than that of benzine and similar products, so that for most uses it is somewhat preferable on that account; but aside from purely technical advantages, it is doubtful if it serves any better purpose in paints and varnishes than is obtained from the use of benzine and similar volatile thinners. At any rate, a prepared paint or a varnish is not necessarily inferior because it is not thinned with turpentine, and it is becoming a very serious question with all manufacturers of such goods whether the time is not at hand when the consuming public will have to be educated to the use of benzine instead of turpentine in their products. The objection is in reality rather to the odor of the first-named product than to any lack of efficiency.

A NEW AND CHEAP PROCESS FOR GENERATING HYDROGEN.

Consul-General Frank H. Mason makes a report from Paris on a new process for producing hydrogen, as follows:

At a recent meeting of the French Academy the eminent physicist, Mr. Moissan, presented a report from Mr. Georges F. Joubert describing a new and thus far secret process for the manufacture of hydrate of calcium, a product which, by reason of its convenient fertility for the generating of hydrogen gas for ballooning and other purposes, is likely to play an important role in the field of applied chemistry.

It appears that the Société d'Electrochemie, at St. Michel de Marienne, has succeeded, like the Electrotechnical Company, at Bitterfield, Germany, in producing by electrical process calcium metal on a commercial scale and at a price so moderate as to permit its use for various industrial purposes.

The invention of Mr. Joubert consists in a process by which the reaction of metallic calcium upon a metallic salt produces the new form of hydrate of calcium, or, as it is commercially known, "hydrolithe." This resembles in appearance and qualities calcium carbide, with the difference that whereas the carbide with the addition of water evolves acetylene gas, the hydrolithe upon contact with water evolves hydrogen gas. When pure, 1 pound of hydrolithe will generate 18.46 cubic feet of hydrogen. When of the ordinary commercial grade of purity, 1 pound of hydrolithe will create 16.05 cubic feet of gas.

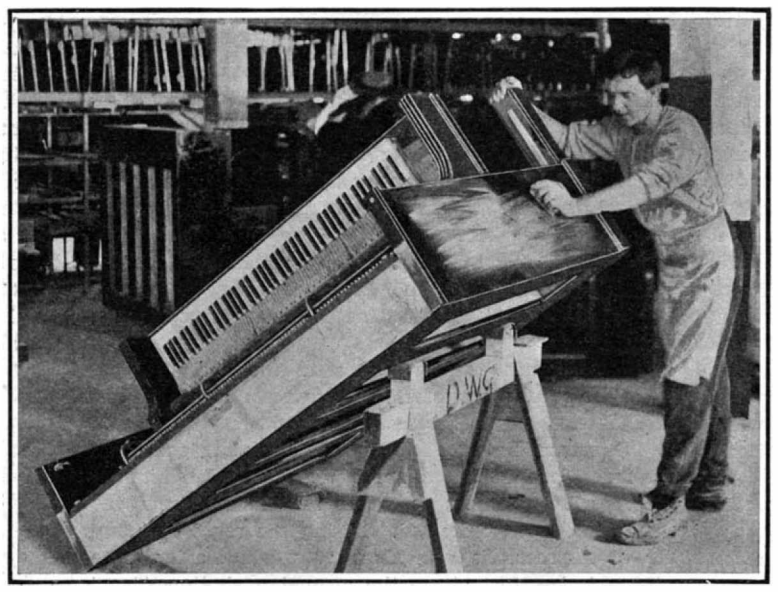
Its most ready and obvious use is thus far for inflating balloons for military and other purposes. It is safe and easy to handle, can be used for generating gas wherever water can be obtained, and for long flights can be carried as ballast instead of sand, and employed at will for refilling the balloon, which may thus be kept in flight almost indefinitely. As an illustration of the economy of weight that has been accomplished by the substitution of hydrolithe for the purposes of military balloon service, it may be stated that an ordinary field balloon contains, when inflated, about 17,657 cubic feet of gas, the generation of which by the means hitherto employed requires the employment of materials and apparatus which fill three wagons, each one of which weighs when loaded 3½ tons, and requires in a campaign to be drawn by six horses. All this cumbrous and costly equipment can now be replaced by a two-horse wagon carrying a ton of "hydrolithe," which, with the addition of water that can be obtained anywhere, supplies instantly and in controllable quantities whatever gas may be required.

A RUSSIAN GASOLINE-ELECTRIC TRAIN.

Experiments have been lately carried on at St. Petersburg with a train using a new system of gasoline-electric locomotive, in which a gasoline engine is combined with an electric motor outfit. The train is made up of six steel cars mounted on two double-axle bogies. The platforms are connected with the bogies by means of ball-bearing pivots. The gage of track is 30 inches and the wheel diameter 12 inches. The rails of the Vignole type weigh 12 pounds per yard. Each car weighs 0.7 ton, and the load is about 2 tons. At the head of the train is placed a car which is like the others on the outside, but it contains in the interior a generating set consisting of a German gasoline motor of 35 horse-power running at 800 revolutions per minute. To the motor shaft is coupled a Bergmann dynamo. The gasoline motor is of the four-cylinder type and has 5.6-inch bore and 6.4-inch stroke. Copper water jackets are used on the cylinders. Speed regulation is secured by varying the proportion of gas in the mixture. The dynamo is designed to furnish 142 amperes and 120 volts at a speed of 780 R. P. M. The weight of the gasoline motor is 0.4 ton, and that of the dynamo 0.8 ton, while the total weight of the locomotive car, including 40 gallons of water, is 2.3 tons. On each of the bogies of the cars of the train is suspended an electric motor, which drives the axle by a 1 to 5 reduction gearing. These motors weigh 110 pounds each, and they operate on a current of 60 volts which is furnished by cables from the dynamo in the locomotive car. The two motors of each car are connected in series. Their speed is 1,000 R. P. M. A four-conductor cable connects all the cars with the locomotive. The motorman can regulate the speed of the train by a controller placed on the front car. This new system is said to operate well.

THE ART OF PIANO MAKING.—II.

In the preceding article on the art of piano making, as carried out at the Knabe factory, we showed that great attention is devoted to the selection and preparation of the wood, so that it shall conduce to the tonal qualities of the piano; described the building up of the rast, or frame; the construction and function of the delicate sounding board, "the soul of the piano"; the manufacture of the plate which serves to carry the combined tension of the strings, and hold the whole structure of the piano to its proper line and surface; and, lastly, we discussed the principles of tone production, and dwelt upon the great care that is taken in the manufacture and selection of the wire for the strings, and in the laying out of the scale.



Polishing the Case. Rubbing Down with Powdered Pumice Stone.

THE PIANO ACTION.—One of the most ingenious and carefully designed and constructed elements in the piano is its action, which is the name given to the delicate and complicated system of rods, levers, and hammers, by which the stroke of the player's fingers, with its infinite variations of touch, is conveyed to the sound-producing element, the strings.

The chief requisites in the piano action are:

1. Lightness, so that the total inertia of the particular key that is struck, and its accessories, shall be as small as possible, and the response to the stroke proportionately quick.

2. Elasticity of touch, or quick return of the key.

3. Sensitiveness to different speeds of attack, so that the performer can produce instantly, and to the proper extent, the effects which he desires.

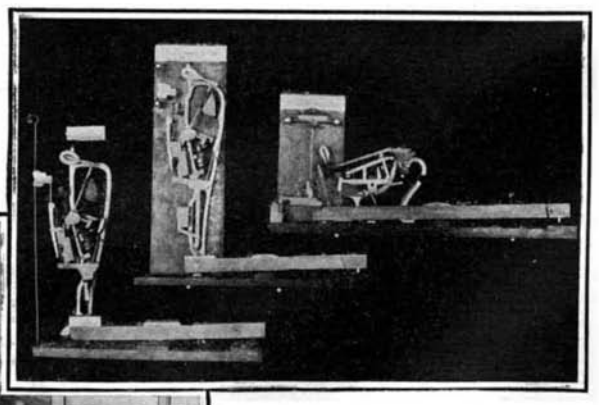
The movement of the action may be briefly summarized as follows: The key, which is struck by the performer, is pivoted at a certain point in its length, and is arranged for transmitting motion from the finger of the performer through the action to the striking hammer. The action is so arranged that the hammer is not driven positively to the string, but to a point which is a short distance therefrom, and the hammer passes over this distance by reason of the momentum already imparted to it by the action. The hammer, after striking the string, rebounds therefrom and is caught by the backcheck and prevented from further movement. When the key is released by the performer, the parts of the action immediately assume the correct position for giving another stroke. Moreover, this position is taken when the key is only partially released, a full return movement of the key not being required before giving another stroke.

Balancing Each Key Individually.

With the striking mechanism for each key is associated a damper, which normally lies in contact with the strings. The same movement of the key that causes the hammer to strike its blow, lifts the damper from the strings just before the blow is struck, the damper closing upon the string when the player's finger is lifted from the key, unless it be prevented from doing so through the operation by the performer of the "loud" or sustaining pedal.

Apart from the energy with which the key is struck by the performer, the blow given by the hammer is dependent upon the distance through which it must travel from its position of rest until it strikes the strings. The soft pedal is a device by which the whole of the hammers may be brought forward toward the strings, thus shortening the stroke and softening the tone. This is the system employed in the upright pianos manufactured by this company. In the grand piano the action of the soft pedal is to shift the hammers from the position in which they strike the three strings that go to the majority of the notes, to a position in which they strike but two of the strings. It is impossible within the limits of the present article to enter into a detailed description of all the pieces that make up the complicated action of a piano, and for such information the reader is referred to the many illustrations accompanying this article, and particularly to the one showing the three styles of action as used in the small upright, the large upright, and the grand. In the upright piano the hammers strike their blow horizontally, and the tone waves are thrown toward the sounding board; in the grand piano the blow is delivered upwardly in a vertical plane, and the tone waves are thrown away from the sounding board. For convenience of manufacture and assembling, the individual members of each part of the action are made of the same length between centers, and pivot upon axes that are in the same horizontal line. This enables the whole of the action as assembled to be mounted upon common supporting rails, which are themselves carried in four metal brackets, one at each end and two arranged between them. The system is shown clearly in several of the illustrations, and notably in that entitled "assembling the action."

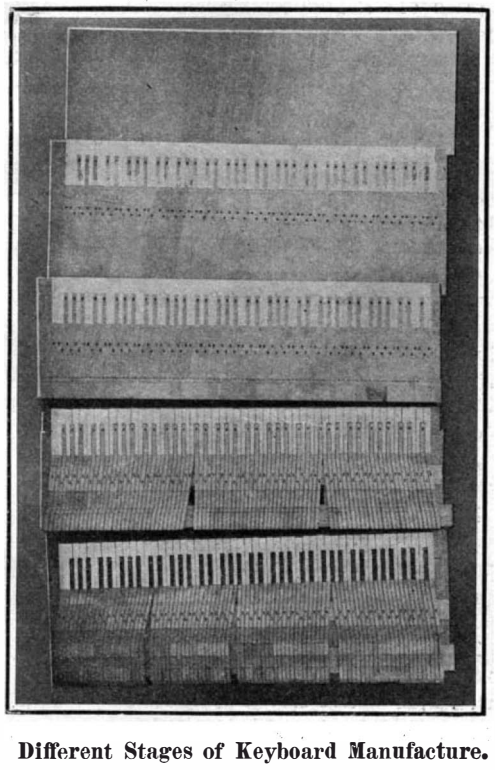
Several different varieties of wood are used in the construction of the action, chief among which are maple, basswood, ash, cherry, and cedar. As it is desirable to make the various parts of the action as light as is consistent with great strength, the wood is so cut that the grain shall, in each member, lie in the direction which is most suitable to the strain which that particular piece must endure. Moreover, the clearance between the separate pieces is so small that the expansion and contraction under atmospheric changes must be reduced to a minimum; and hence, in those parts upon which the maintenance of proper clearance depends, when not inconsistent with maintaining the strength above mentioned, the grain is made to run crosswise of the general plane of the action, wood having practically no expansion or contraction in the direction of the grain.



Complete Actions for Small and Large Upright and the Grand Pianos.

Adjusting the Grand Action.

THE HAMMERS.—The hammers are made with a round shank and a head approximately pear-shaped in profile. The nucleus or center of the head is a small wedge-shaped piece of hard wood, around the point of which is first glued a piece of under felt, which acts as a cushion for the thicker outer felt that does the striking. Because of the severe and long-continued hammering to which it is subjected, it is necessary to use a special grade of felt for covering the hammers. The best quality comes from Germany in the form of large sheets, 4 feet square and tapering in thickness from 1 1-16 inch at one edge to 3-16 of an inch at the opposite edge. The whole set of eighty-eight hammers during the first process of its fabrication is operated upon as one piece. The wedge-shaped strip of wood forming the nucleus of the hammer head is held in the jaws of a specially constructed press, and the inner or cushioning strip of felt is glued on, and then a strip about 5 inches wide, with



Different Stages of Keyboard Manufacture.

Note grain of wood parallel with slope of the keys.

Regulating the Action of a Grand Piano.

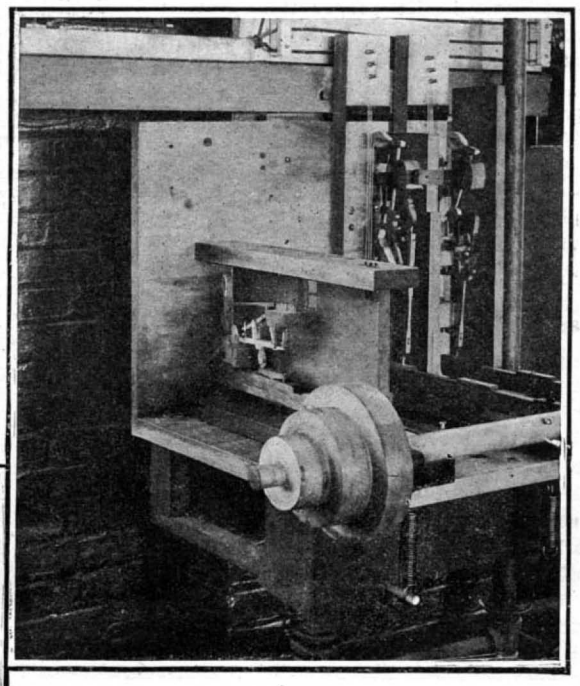
its edges chamfered down, is cut from the sheet of outer felt and glued down, under great pressure, in the jaws of a powerful machine, over the inner felt until it assumes the characteristic pear-shaped profile of the hammers. When the glue has thoroughly set, the felted strip is cut transversely into the requisite number of hammers. The thickness of the felt decreases gradually from 1 3-16 inches in the lowest bass hammers to 3-16 of an inch in the hammers for the highest treble notes. How special a quality of felt must be used in a first-class piano is shown by the fact that each of these sheets costs $125. We explained in the previous article that the scale of the piano strings is so arranged that the points at which the hammers strike the strings shall lie on a straight line; and one of the most careful adjustments is that of regulating the length of the hammer shank, so that the hammer shall strike neither above nor below this line. This adjustment is made by passing a file over the bottom end of the hammer shank until it is lowered to its proper relative position.

THE DAMPERS.—Acting upon each string in its proper relation to the blow of the hammer is a damper, which consists of a piece of soft felt, that normally is held against the string by a light spring, but is lifted from it just before the hammer strikes a blow, and returns to contact when the player's finger is lifted from the key. It is necessary that the tension on the dampers should be mathematically co-ordinated to the force with which the string vibrates, and this adjustment is secured by a careful operation, known as "weighing off the dampers," in which the tension of the spring is tested by means of a weight, each spring being adjusted so that it will exactly counterbalance this weight, and secure an identical speed of action of all the dampers when in use.

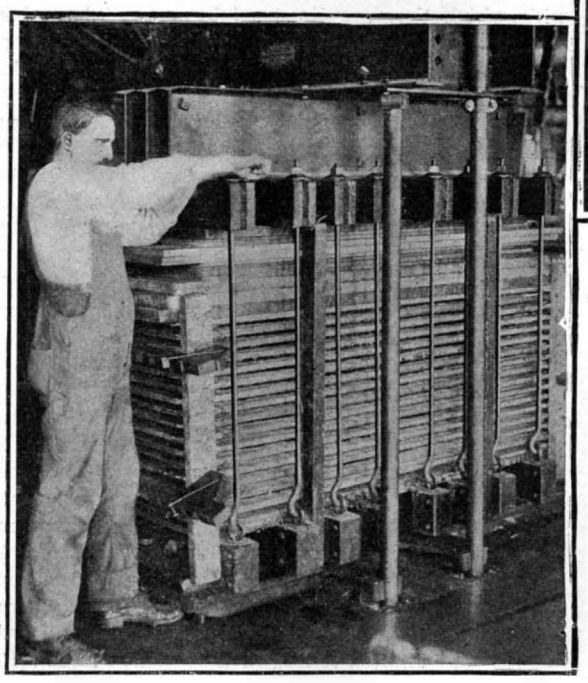
THE KEYBOARD.—As in the case of the hammers, the eighty-eight members of the keyboard are, in the earlier stages of their manufacture, formed in one piece, consisting of a board of white pine, composed of several widths glued together with the grain so arranged that it shall run approximately in the direction of the finished keys. By reference to the engraving showing five stages of the construction of the piano keys, it will be noticed that some of the keys bend to the left, others to the right, and it is necessary to have the grain running in the direction of these bends in order to secure the proper transverse strength. The board, as first glued up, dressed, and finished to size, is about 1 inch thick by 2 feet wide by 6 feet long. The first step is to glue down along one of the long edges of the board a thin ivory strip, after which the top ivory is glued on. The board is then spaced off into the proper number of keys. A double line of holes is then drilled across the board at about its mid-length, for the reception of the pins by which the keys are held in position on the key frame. The keys are now accurately lined upon the board and sawn out with a band or fret saw, after which the ebony keys are glued down upon the proper members. The whole set is now ready for assembling in the piano.

ADJUSTING THE KEYS.—Each key is pivoted at about its mid-lengh upon a rounded saddle, resting on the key frame. It is kept in proper line by means of two nickel-plated pins, one fixed in the saddle and passing up through a slotted hole lined with felt in the center of the key, and the other pin projecting near the forward edge of the key frame, and engaging another slotted and felted hole near the front end of the key. It is necessary, because of the small clearance between adjoining keys, that they all move in a perfectly vertical plane, and one of our photographs shows the workmen employed in the task of adjusting the keys in this respect, the adjustment being made by bending the pins slightly to right or left, as required.

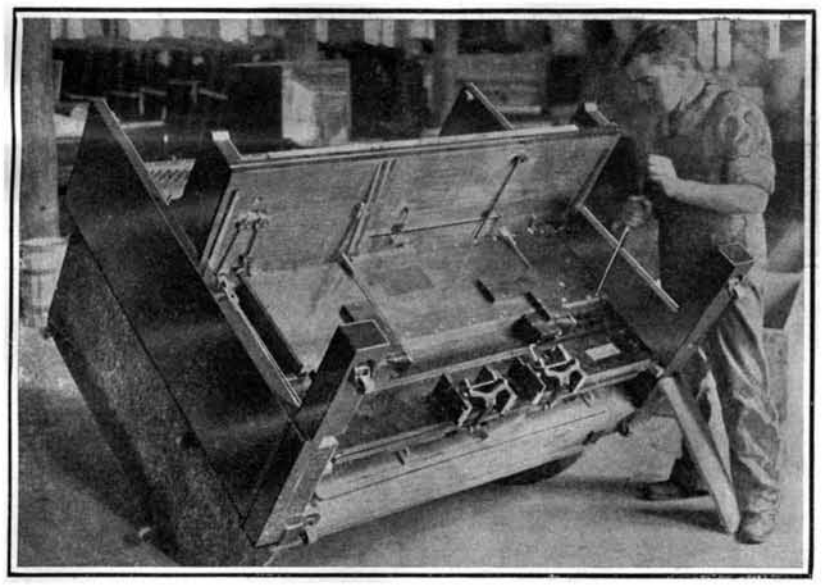
REGULATING FOR TOUCH.—One of the points to which particular attention is paid in the construction of the Knabe piano, is to secure an easy, light, and rapid response of the keys to the stroke of the fingers. Normally, the keys are depressed at the inner end, being held down by the weight of the action above them. As the weight of the action varies greatly, being heavier at the bass end of the scale, it is necessary to weigh the outer end of the keys, so as to bring the excess load on the inner end to the same amount for every key, otherwise it would require greater strength to depress the keys in the bass register than in the treble. This balance is secured by inserting one or more lead plugs on the outer ends of the keys, the amount being determined by an operator who is specially trained for this work. Another important question affecting the touch is the depth of stroke, or vertical distance through which the key is depressed in playing. This regulation is made by interposing little circular washers of felt or other cushioning material between the outer end of the key and the key frame below it. Specially-trained workmen are detailed to do this work, and by long practice their fingers have become so trained, that they can detect the slight change in the depth of the touch amounting to as little as 3-1000 of an inch, due to variations in the down-stroke caused by the insertion or withdrawal of a washer as thin as ordinary tissue paper. Concurrently with this adjustment great care is taken to insure that the



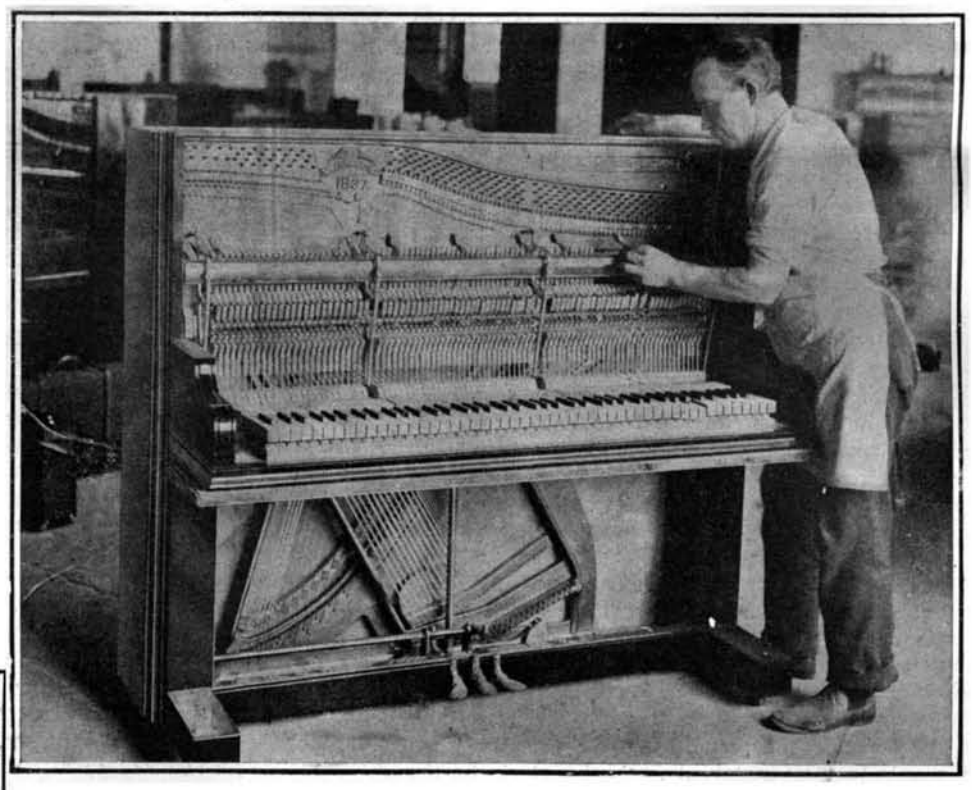
Machine for Testing Action, Hammer, Felt and Cloth.



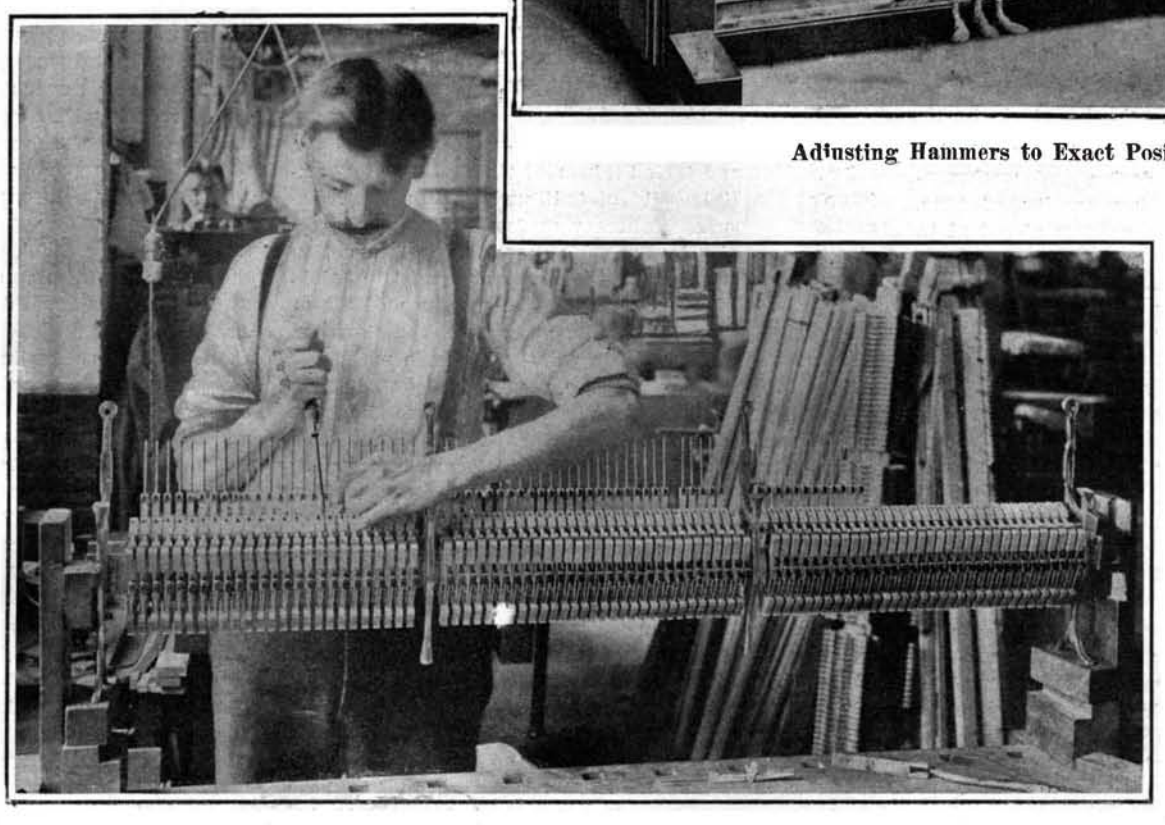
Glueing On Veneer in 120-Ton Hydraulic Press.



Installing Automatic Piano-Player Action.



Adjusting Hammers to Exact Position.



Assembling the Action.

THE ART OF PIANO MAKING.—II.

"release" acts in its proper time relation with the movement of the key.

Tuning and Tone Regulating.—When the action has been thoroughly adjusted, the piano is taken in hand by the tuners, and as an evidence of the thoroughness with which this important work is carried through at the Knabe works, we may mention that each piano undergoes no less than sixteen separate tunings, viz.: Four chippings or preliminary tunings, ten regular tunings, and two fine tunings. Tone regulating or "voicing" is, perhaps, the most important of the final adjustments to which the finished piano is subjected. The object of tone regulating is to weaken or destroy certain "upper partials" or overtones, which would otherwise give a harsh quality to the tone. This is done by pricking the felt with a needle-pointed instrument to soften the hammer near the point where it strikes the strings. This causes the hammers to remain longer on the strings, and secures the effect of dampening certain of the inharmonic overtones. It is a work that requires a most delicate ear, and the number of really first-class tone regulators in the country is very limited.

Veneering and Varnishing.—Not a little of the charm of a first-class piano lies in its inherent beauty considered as an object of artistic furnishing. The first-class makers recognize the necessity for bringing the form and finish of the piano up to the high level of its musical quality. The piano owes much of its beauty of finish to the art of veneering, and the world is ransacked in the search for fine veneers, mahogany being the most preferred, while rosewood, walnut, birch, English oak, and Hungarian ash are all largely used. The finest veneers are cut from near the root, or from the root itself. The body of the piano case is of quartered ash, and the veneers are all glued on in double thicknesses, the grain of one layer running transversely to that of the other.

The bringing forth of the latent beauty of the grain is due largely to the judicious use of staining; and a large amount of experimental research is always going on in the testing department of the Knabe works for new and more effective stains. Incidentally we might note that this testing department is unique in its way, for we believe that it is the only one of its kind in the world. Among its apparatus we find a Riehle 100-ton testing machine, for tensile and crushing strength of iron or steel; a sonometer, an ingenious machine for determining the breaking strain of steel wire, or the number of pounds strain necessary to pull any certain size and length of wire to a certain pitch or tone; an action-testing machine for testing the durability of felts, cloth, hammers, and other parts of the action; and numerous other devices, all specially built for the one purpose of determining what particular material is the best, and best suited to its particular function.

The varnishing is a slow and costly process, involving seven distinct coats and twenty-one processes. First a coat of varnish is put on with the brush. The brush marks are then rubbed out with pumice stone, the pumice-stone marks by rotten stone, and finally the rotten-stone marks by the hand, there being no polishing agent to equal the human skin. These steps are successively carried out for each of the seven coats; after which the case presents the desired grain and luster.

The finished piano is now subjected to the final examination and test, and as a matter of fact passes through the hands of five different inspectors, after which it is ready for the showroom. The construction of a piano at the Knabe works takes from six months to two years, according to the style and design, the time being reckoned from the day when the rough lumber is taken from the stack to the wood mill. The finished product embodies all that careful attention to details of design and workmanship, and that distinctive singing quality of tone, which, as we have seen, are the qualities aimed at in the production of this instrument.

Salving "Fireproof" Safes and Their Contents After the Great Fire of San Francisco.

BY ARTHUR INKERSLEY.

Since the great fire of San Francisco burned itself out, the safe experts have been the most important persons in the ruined city. The financial existence and commercial future of many individuals and firms depended upon the contents of vaults or safes warranted proof against any assault of man or the elements. As soon as circumstances permitted, safes were dragged out of the debris and allowed to cool. In many instances the eagerness of their owners proved fatal—the safes were opened before they had cooled sufficiently and, when air was admitted, the contents burst into flames. In other cases, the safes remained buried in the hot debris till their contents were baked and charred beyond recognition. The only chance to rescue anything from a safe buried in hot debris is to get it out as quickly as possible and to cool it by wrapping it in wet sacks or blankets. Then it is fairly probable that, on being opened, the contents will be found uninjured or not hopelessly ruined. But, if the safe is allowed to remain in the smoldering ruins, its contents are "cooked" and crumble into ashes as soon as the safe is opened and air admitted. Even coin is melted into a lump of bullion. A safe that looks all right outside, being neither cracked, dented, nor warped, may yet be "cooked" and its contents useless. If the books and records are burned, the owner may find himself ruined, whereas, if they are in reasonably good condition, he may be able to begin business again without any very serious loss.

It is sad to have to say that the San Francisco fire has demonstrated the worthlessness of many safes and vaults guaranteed by the manufacturers to be proof against burglars and fire. The manufacturers, dealers, and agents have in many instances been shown to have sold "fireproof" safes that were of little more value than wooden boxes, and the "fireproof" compositions with which they are lined might as well have been sawdust. It is to be sincerely hoped that the manufacturers of and dealers in these worse than worthless devices may be put out of business for all time.

Some of the "fireproof" vaults in office buildings have turned out equally valueless for the purposes for which they were intended. They had imposing steel doors, with locks, bolts, and elaborate combinations, but their backs were the walls of the building. The intense heat of the conflagration, the shock of the earthquake or the concussion of exploding dynamite brought the wall down and there was a "burglar- and fireproof" vault or safe without any back.

F. M. Smith, the "borax king," had three safes in a building at the corner of Sansome and Bush Streets. One of these, containing securities and diamonds, was found uninjured, but the papers and books in the other two were consumed.

The banks and safe deposit companies were, naturally, slow in opening their vaults and strong rooms, not wishing to jeopardize their invaluable contents by haste. In every instance their contents were found to be unharmed. Several of the companies opened their vaults on May 7 and the renters of safety deposit boxes were delighted to find their treasures intact. For many days previously they had been making anxious inquiries, but had been turned away by watchmen and United States soldiers. Some of them took out the money or jewelry contained in the boxes, while others, after poring over their treasures for a little while, put them back again, feeling that their keepsakes and valuable documents, after passing safely through such ordeals as the earthquake and fire, were secure.

In one bank on Market Street the safe deposit boxes were unharmed, but a large vault, extending under the sidewalk and the floor of the bank, was broken by the wall from a neighboring building that fell upon it, crushing the ceiling of iron and cement and allowing ingress to the flames. In this vault were stored silver plate, laces, and other valuable articles, too bulky to be placed in the steel boxes. Many of these articles were in large tin boxes or even in trunks and suit cases. They were ranged on iron shelves, from which they fell and became a prey to the devouring flames.

On the same day (May 7), only seventeen days after the fire died out, the American National Bank resumed business in the quarters that it occupied previously in the ground floor of the Merchants' Exchange Building on California Street, being the first banking corporation to return to the old business center. The building was swept by flames and all the combustible material in it was consumed, yet in less than three weeks a bank was able to open again in it. It proves how rapidly a modern steel and concrete earthquake- and fire-proof structure can be refitted for use. On the opposite side of the main entrance the San Francisco National Bank resumed operations a few days later.

Preservation of Records from Fire.

Prof. Edmund O'Neill, dean of the College of Chemistry at the University of California, offers some suggestions to persons whose records may have been destroyed partially by fire. He says: "The destruction of organic matter by fire is dependent upon two points—increase of temperature and the presence of air or oxygen. If excess of air be present on the elevation of temperature to igniting point, the whole mass will burn up completely. If the air is kept out, but an elevated temperature is maintained for some time, the paper will be slowly destroyed. Volatile matter is given off and finally the residue of carbon, more or less pure, is left behind. This carbonaceous residue is very friable and difficult to handle. The temperature of decomposition is not very high and varies according to the quality of paper. It begins below 300 deg. F. and becomes more rapid as the temperature increases. But a comparatively low temperature long continued will destroy the paper as effectually as a higher temperature.

"The safety of paper inclosed in so-called 'fire-proof' safes depends upon the heat insulation, and the more non-conducting and the thicker the layer of fire-proof material the longer it will take to transmit the heat to the inner chamber. But if the safe is covered with hot or glowing material, it is simply a question of time when the heat will be transmitted into the inner chamber and cause the paper to decompose. The sooner the safe can be removed from its hot bed and cooled to normal temperature, the better it is for the papers contained therein. The better the safe the more slowly it will cool, and such safes should be left much longer before opening than the small and poorer ones. If air be admitted before the temperature has sunk below the point of ignition, the papers will take fire instantly when exposed to a current of air. The temperature of ignition is about 300 deg. F., and, if it is not certain that the interior of the safe is cooled below that temperature, it will be dangerous to open it. The cooling may be hastened by the withdrawal of the safe from its hot bed. Covering it with sacks or cloth or other porous material and pouring water upon it will also hasten the cooling to a great degree. The ignition may also be stopped by preventing the access of air, but methods for doing this are cumbersome. Steam from wet sacks would probably be the most efficient agent to prevent the access of air. When the interior of the safe is cooled below the igniting point, there is no danger in opening and removing the documents.

"If the paper be charred so that the writing is apparently illegible, the sheets may be removed one by one and laid on plates of glass. Frequently the writing may be read by holding the sheets at a certain angle so that the reflection of light from the inked surface is distinct. The legibility is sometimes increased by moistening the paper with water. Chemical methods of rendering the writing visible may be employed in some cases.

"Inks are of two classes—those in which metallic salts are used, and those in which organic coloring matters, mainly anilines, are employed. Inks of the first class are usually tannates or gallates of iron or logwood bichromates. Many methods have been tried in the laboratory of the University of California to cause the residues to assume a different color from that of the carbonized paper. The most successful results have been attained by brushing the paper with a diluted solution of hydrochloric acid. Subsequent brushing with a solution of potassium ferro-cyanide has sometimes proved effectual. Other reagents that have produced good results in particular cases are tannic acid and ammonium sulphide. It is intended to try the effect of X-rays and Becquerel rays. It is possible that they may prove successful. The problem is a complicated one, the composition of inks being so varied and the qualities and textures of paper so different. Then, the temperature and the time are not always the same, so that the procedure must vary according to circumstances. In some cases the writing is brought out very clearly, while in others the same method is not at all successful."

The importance of the safe expert is shown by the fact that the first business place set up on Market Street, San Francisco, after the fire was that of "Hughson & Merton, Representing Eastern Manufacturers," and of the "G. W. Emmons Company, Safe-Moving and Draying." The establishment consists of a rough wooden shack and a khaki tent set up on granite blocks a few feet from the car tracks.

San Francisco Notes.

The sub-committee on history of the Committee of Fifty has intrusted to Prof. Henry Morse Stephens, of the University of California, the task of compiling an accurate and complete record of the San Francisco earthquake and great fire and of the relief work necessitated thereby. Mayor Eugene E. Schmitz, of San Francisco, has given an order that all the official documents be turned over to Prof. Stephens, and has asked Gen. Frederick Funston, commanding the Department of California, and the military authorities to co-operate with him in preparing the papers.

Prof. Stephens proposes to divide the history into three sections, devoted respectively to the earthquake, the fire, and the relief work. The history will end with the restoration of normal conditions and the beginning of the projected rebuilding of a greater San Francisco. Prof. Stephens will be assisted by C. H. Parker and D. E. Smith, readers in the history department of the University of California. Mr. Parker will collect the data, with copies of official proclamations and orders, and Mr. Smith will segregate and catalogue them. Both will have the help of several deputies.

A. C. Lawson, professor of mineralogy and geology at the University of California, is making an investigation of the movements and effects of the earthquake, gathering the personal opinions of various officials on duty during the disaster, and commenting on the manner in which affairs were managed during the period immediately following the catastrophe. Prof. Lawson's contribution will be added to the general history.

A large deposit of clay has been discovered in Monterey County, California, from which can be manufactured an absolutely fireproof brick. A house built of these bricks cannot catch fire from the outside and flames inside are quenched by a vapor that rises from the brick when heat is applied to it. The brick is an excellent non-conductor, and remains cold an inch be-

low the surface while a hot flame from a gasoline torch is directed against it. Experiments have been made with the new brick, of which a report has been presented to the Merchants' Association of Monterey. The deposits of clay from which the brick is made are very extensive and the brick can be manufactured cheaply.

The Merchants' Association will conduct further experiments, and, if the bricks prove to be satisfactory, the building of fireproof structures will be revolutionized.

One of the remarkable incidents of the great fire of San Francisco was the immunity from damage of an old wooden shack owned by the American Marine Paint Company at the corner of Main and Harrison Streets. The ramshackle, half-century-old building stands unharmed, a little island in a sea of desolation. It reeks with oil and is filled with highly inflammable materials. Quite near to it a great pile of coal caught fire and burned for nearly a week. The officials of the company felt so certain that the place had fallen a victim to the devouring flames that they did not even attempt to visit it until two weeks or so after the conflagration, and then it was mere curiosity to see what the ruins looked like that led them there. Their astonishment when they saw their oil-soaked wooden store standing unharmed amid the ruins of "fireproof" buildings can easily be imagined.

California Fruit as Affected by the Earthquake.

The writer has made careful inquiry concerning the present prospects of the California fruit crop, and the response to each inquiry is to the effect that the recent convulsion will not diminish its value by a single dollar. The only considerable locality where fruit was the leading commercial interest was in the Santa Clara Valley, where the property losses were large, but fruit suffered no injury whatever. Apricots, the earliest fruit to ripen, will not be in large supply this year on account of climatic peculiarities, the result of too abundant rains, unseasonably prolonged. Cherries, at the present moment, are in splendid condition and the prospect, barring future eventualities, is most excellent. Plums, should every indication be fulfilled, will be in larger supply and better in quality than for many years. In each of these fruits, now in an advanced stage, a careful inspection of the orchards over a wide area fails to show that a single apricot, peach (also in large prospective supply), cherry, or plum, was shaken from the branches by the shock which prostrated some of the finest and largest buildings in every community where its violence was greatest. It is yet too early to make observations on the future of the grape crop. It is invariably the rule in European countries, that "an earthquake year always assures a full vineyard," and if the rule proves good in California, the grape crop of the present year should prove a phenomenal one. A competent authority estimates the quantity of wine consumed in the late San Francisco fire as exceeding 20,000,000 gallons, or nearly one-half year's production, mostly of old, high-quality wines; therefore there will be demand for every gallon which the vineyards can produce. The excellent prospect in every agricultural product is distinctly encouraging to the State, though many months must elapse before mercantile interests will benefit from the new supplies.

The Current Supplement.

The current SUPPLEMENT, No. 1586, opens with an article on the damage sustained by the Leland Stanford, Jr., University during the recent earthquake. Very striking pictures accompany the article showing the condition of the University buildings before and after the catastrophe. Some simple tests for the detection of food adulterants are published, which will enable the housewife to ascertain whether or not her provisions are pure. Mr. James P. Maginnis's article on Reservoir, Fountain, and Stylographic Pens is continued. An excellent article is published on the utilization of solar heat for industrial purposes by means of a new plane mirror reflector. A novel device for the making of curved stereotype printing plates for newspapers is described and illustrated. A new seating arrangement for street cars is described and illustrated. Mr. William L. Larkin presents a very complete account of concrete mixing machinery. A scientific account of the San Francisco earthquakes is published.

Paper Gas Pipes.

An interesting employment of paper relates to the production of gas pipes. Manila paper cut in strips, of a width equal to the length of the pipes to be made, is put in a receiver filled with fused asphalt and rolled solidly and uniformly around a rod or core of iron until the desired thickness is obtained. After the pipe thus produced has been submitted to strong pressure, the exterior is covered with sand and the whole cooled in water. The core is removed and the outer surface covered with a water-proof product. These pipes, it appears, are perfectly tight and more economical than metal pipes.—Rev. de Chimie Industrielle.

Correspondence.

Spontaneous Combustion.

To the Editor of the SCIENTIFIC AMERICAN:

A curious case of spontaneous combustion came under my notice a few days ago. A number of matches which were lying loose upon a shelf ignited and burned without apparent friction or contact with a flame of any kind. The day, March 30, about 11 A. M., was foggy and cloudy. I was seated with my back toward the shelf, when I suddenly noticed a flash not unlike that which takes place when a large lamp is lighted, and on looking around I saw the matches blazing on the shelf.

Had this occurrence taken place at night among papers, or in some person's pocket, it might have been the origin of one of those unaccountable fires which appear to be unpleasantly prevalent. Of course, spontaneous combustion is neither novel nor always unexplainable, and possibly may occur more easily with matches than with other articles. This appears to prove, however, that matches should be packed and handled with greater care than is usually given to them.

At the time that the case I mention took place, there was no fire near the shelf, nor anything on the same that would appear to be capable of causing friction. Is it possible that the ignition was due to an atmospheric cause, or could it be owing in any way to the chemical composition of the match or matches which ignited first?

This seems to me to be a rather serious question for fire insurance companies, as well as factory owners and householders generally. Matches should be handled with far greater care than is usually the case, and should, for instance, be kept entirely out of reach of children. I am convinced from what I saw in this case that certain kinds of matches at least are extremely liable to be ignited spontaneously.

East Orange, N. J. WILLIAM DEWART.

Fertilizing Power of the White Ant.

To the Editor of the SCIENTIFIC AMERICAN:

Your article of February 17 last regarding the fertilizing powers of the white ant is correct. I left Montpelier, Idaho, in 1887, and since then have lived among the natives of this African east coast. Every season I have seen the wonderful effects the white ant hill produces on the Kafirs' maize and corn. Whenever there happens to be an ant hill in their gardens, its immediate vicinity can be at once distinguished, as the maize and corn are fully double the size of the surrounding crop. The statement that some parts of the country are uninhabitable on account of the white ants is incorrect so far as this vicinity is concerned, as they are easily prevented from entering buildings, and do not attack green crops to any extent. The bush country a few miles from this place is swarming with white ants, and has also a large native population, and my experience is that the ants do more good than harm if necessary precautions are taken with buildings.

REG. SPRINGLE.

Mbabane, Swaziland, South Africa.

Earthquake at the Home of Luther Burbank.

BY ENOS BROWN, CALIFORNIA CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Nowhere in the limited area to which the late California earthquake was confined were the terrific destructive powers of the convulsion manifested with greater violence than at Santa Rosa, the capital of Sonoma County and one of the most beautiful rural communities in the State. Santa Rosa has been the home of the most wonderful of horticulturists for over thirty years, and the scene of all those remarkable developments which have, in recent years, astonished naturalists throughout the civilized world. Notwithstanding the appalling catastrophe which has brought misery and misfortune to many friends and neighbors, the renowned scientist welcomed the representative of the SCIENTIFIC AMERICAN with great cordiality, and proceeded at once, to the exclusion of all other subjects, to talk upon the strange features of the shock as exhibited under his own personal observation. "I arose at 5 o'clock, as invariably my custom," said Mr. Burbank, "and was looking out of my window at the moment the shock began. A great spreading elm tree in the back yard seemed trying to uproot itself, and swayed in every direction. First the branches turned half way around to the right, and then reversed in the contrary direction; again the great tree marched toward the east, and then back to the west. The trunk then appeared to rise from the ground and try to eject itself from the earth, and did not cease from its extraordinary motions until all movement of the ground had stopped. I then rushed into the garden, and naturally expected that a terrible scene of destruction would meet my gaze, but to my amazement not the tenderest leaf or the most delicate plant had been broken. Not even a single pane of glass in any of my greenhouses suffered from fracture, neither had a solitary flower-pot been thrown from the shelves, yet within two blocks of my house, right in sight, a mile of the most substantial brick buildings in the county had been prostrated to the ground and were a few minutes later in a blaze. The beautiful court house was all but destroyed, while hotels, business blocks, theaters, and many private dwellings shared in the common ruin, all this happening in a space not exceeding one and one-quarter minutes.

"The first shock came from the west and then turned and came back from the east, afterward appearing to twist around in a circle, racking the buildings and involving them in utter destruction."

Not a brick or stone structure in a space 3,000 feet in length and 600 feet wide escaped destruction; the heart of the city was involved in a minute and one-quarter in total ruin. Strangely enough, frame buildings, those even of the lightest construction, were comparatively unharmed, suffering no greater damage than from broken plaster or breakage of rotten timbers. The financial loss to the beautiful city will reach from $3,500,000 to $4,000,000 but a more dreadful consequence was the fatality attending the catastrophe, which cannot be accurately determined. Seventy-eight bodies were recovered. Had Santa Rosa been the only locality involved in the catastrophe, the loss of life and property would have caused it to have been recorded as the most terrible earthquake visitation known to the history of the State; but, overshadowed by the tremendous upheaval at San Francisco, the magnitude of the Santa Rosa cataclysm is almost lost to sight.

The work of rebuilding is now proceeding in energetic fashion, and a different aspect than at present afflicts the spectator will soon be presented. Hundreds of workmen are busily engaged in erecting one, two, and three-story buildings, and it will not be many months before all visible signs of the disaster will have vanished. Every hotel of any pretension—and there were a number of them—was either destroyed by the shock or by fire, but the proprietor of one was equal to the emergency. The new St. Rose is the first to rise from its ashes, not as a structure of brick or mortar as before, but in the shape of a great tent, capacious enough for 250 bedrooms and fitted with every appurtenance of modern travel and comfort, with the added novelty of perfect ventilation and safety from seismic disturbances. The energetic citizens have determined on a new plan for their city, in which wide streets will be a prominent feature.

AN AUTOMOBILE SCHOOL.

The remarkable development in the automobile industry, and the swift advances in automobile construction within recent years, have produced unexpected and unforeseen conditions, and one of the most striking phases in the situation is the lack of men trained to manage and care for the high-powered cars which are being turned out of the factories by the thousand here and imported from abroad. The high salaries that have been offered for drivers and experts, and the pleasant character of the work itself, have attracted the attention of young men of all classes, and hundreds of these have applied to factories and garages with offers to work without compensation merely in order to acquire mechanical training in this line. The superficial automobile engineering education thus obtained has been accepted on the principle that a half-trained chauffeur is better than none at all. Manufacturers of popular cars have estimated that three-quarters of the troubles reported to them by automobile owners are the results of inefficient handling rather than of inherent defects in the mechanism; and to-day the selection of a driver has become almost as important as the choosing of the car. It was to relieve this condition that the New York School of Automobile Engineers in New York city was incorporated, and Prof. Charles E. Lucke, of the Department of Engineering of Columbia University, was invited to plan courses and to supervise a general scheme of instruction that would give thorough training in the principles involved in the construction and handling of automobiles of all types, as well as in the solution of the many practical problems confronting the chauffeur. That the plan of the school has been successful in attaining the object for which it was designed, is attested by the fact that of over a hundred students who have completed the course, none has failed to give satisfaction to his employer.

The building occupied by the school is equipped with shops and laboratories that cover the entire field, and students are accepted for the eight weeks' course only after an examination that proves sufficient ability to grasp the work. Various departments of the school are illustrated in the accompanying engravings.

The men are formed into graded squads of from twelve to fifteen each, and the course is divided into five departments, which include lectures and recitations, practice in the workships, and the study of transmissions and engines, of carburetion and lubrication, and of ignition. The men pass through this cycle four times a week. Various other phases of automo-

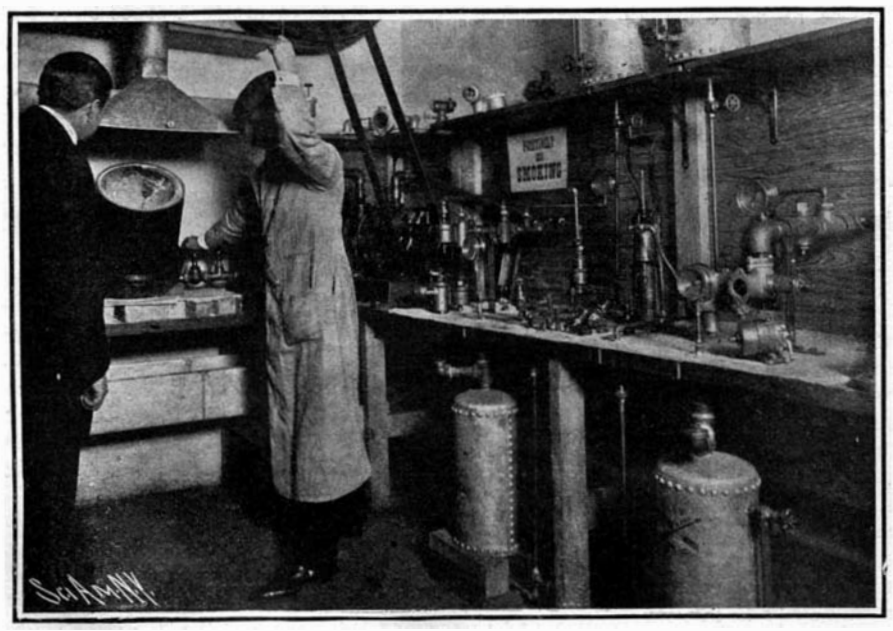
bile engineering are, of course, included in one or the other of the five general divisions, and the student is unfamiliar with no detail of the automobile at the end of the course.

Each of the general departments is in charge of an experienced instructor, who begins his work with extended lectures on the elementary principles involved, advancing at each period and holding occasional examinations to assure himself that every step has been thoroughly comprehended. For example, a squad in the carburetion department will study the primary action of the liquid seeking its own level, and will follow that with the application of the principle as worked out in the various designs, finally taking each type of carbureter in action. For this purpose an exhaust fan with variable speed draws either warm or cold air through the carbureter in question, and the mixture is then burned in an open crucible, where the actual difference between good and faulty adjustment is illustrated by the color of the flames. The ignition department has been worked out with the special care which the importance of this detail of the subject warrants, and each step is so thoroughly explained and illustrated in each of the various systems, that the principles can readily be grasped and applied.

Engines and transmissions of all types must be mastered under all conditions of faulty lubrication, loss of compression, etc., and the motors and gear systems are isolated, so that in studying them the pupil's attention is not distracted by other parts of the car's mechanism. Engines of many types are provided for the purpose of familiarizing the student with them, and to facilitate this portion of the instruction the models are partially cut away, more clearly to illustrate their interior construction. Where a model of a particular type of engine has not been obtained, the students are provided with detailed plans and concise descriptions which they must study thoroughly. Various types of transmissions are mounted in frames and belt-driven, that they may be studied in motion and with any combination of gears. All classes of repairs, temporary and permanent, are taught in the machine tool shop, where practice with forges, lathes, drill presses, and shapers, supplemented with bench work, is included in the instruction. The students are taught how to make brake horse-power tests of engines, and in these tests the effect of various conditions, such as absence of muffler or jacket water, upon the engine are studied. One interesting feature of the course is the instruction in the avoidance of tire trouble and in the methods of making repairs when it occurs.

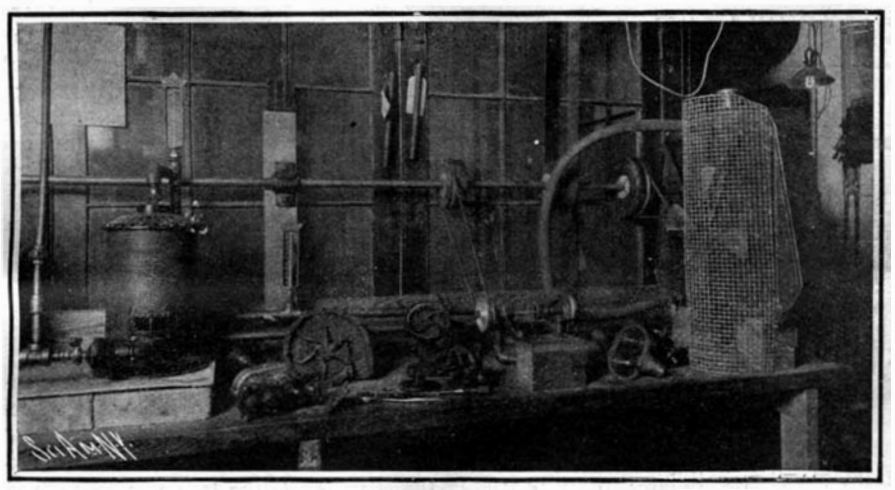
The first practice in handling change-speed gears is given to the student in a complete car set on rollers, and in this way control of the car—starting, stopping, reversing, and braking—can be learned with greater rapidity, for the student is independent of the worries incident to steering and the speed limits. The first instruction in the handling of cars on the road is given on Morris Park race track, where for a week the students have simple running conditions, but are incidentally—and purposely—introduced to all kinds of possible trouble. Every difficulty will be encountered, and the failure of a student to get his car running and keep it running, will count against him in the granting of his certificate of graduation. The experience at the race track is followed by a week's experience operating through traffic and among city conditions, and beyond that the student only requires practice to become thoroughly competent for any work in driving or manufacturing that may be offered.

In the organization of the school's equipment the manufacturers of cars and parts, recognizing the advantage of having men trained in their designs, have offered all their specialties, and for this reason the course is remarkably complete and of the most practical benefit. One interesting feature of the situation is the eagerness with which owners of automobiles have taken up the special course open for them.

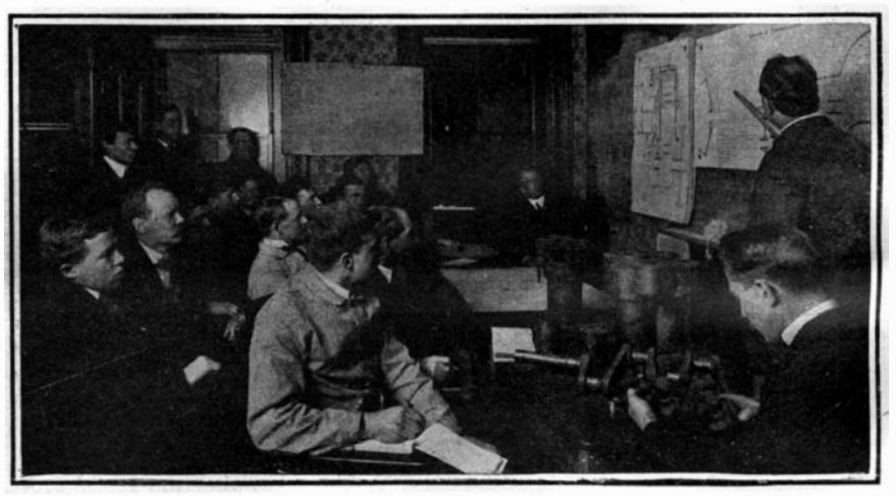


Burning Mixture From a Carbureter in an Open Crucible.

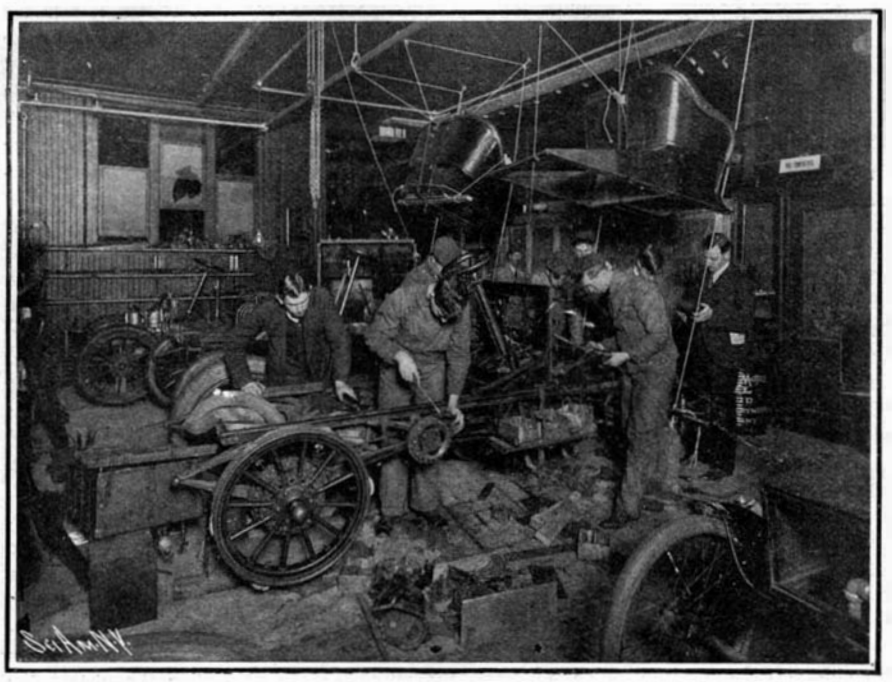
Overhauling a Car Prior to Traffic Practice.



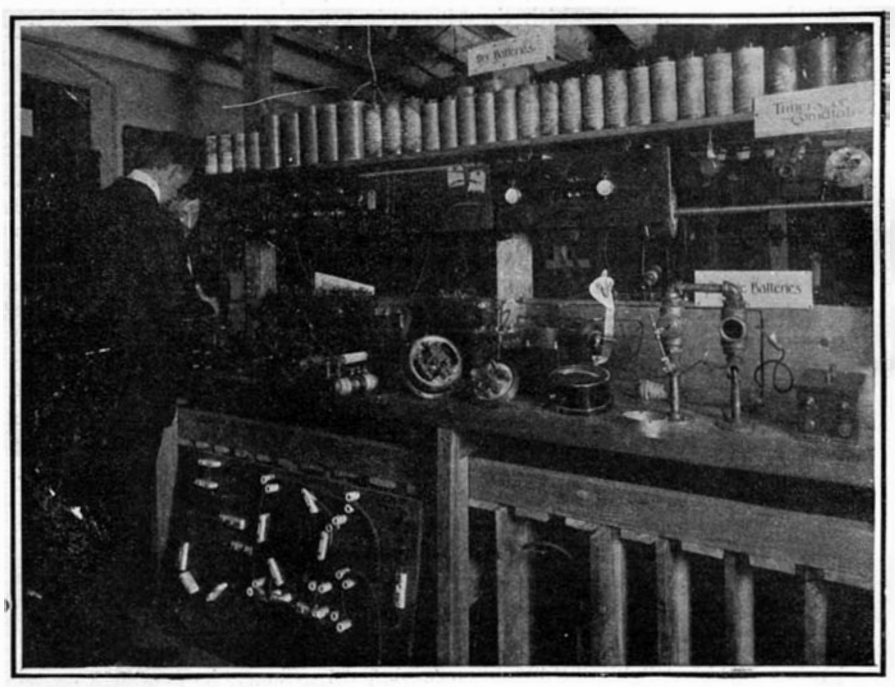
Circulating Pumps and Radiator Department.



Theoretical Work in the Lecture Room Before Studying the Principles in Practice.



Practice in Assembling Parts of an Automobile.



Studying Various Systems of Ignition.

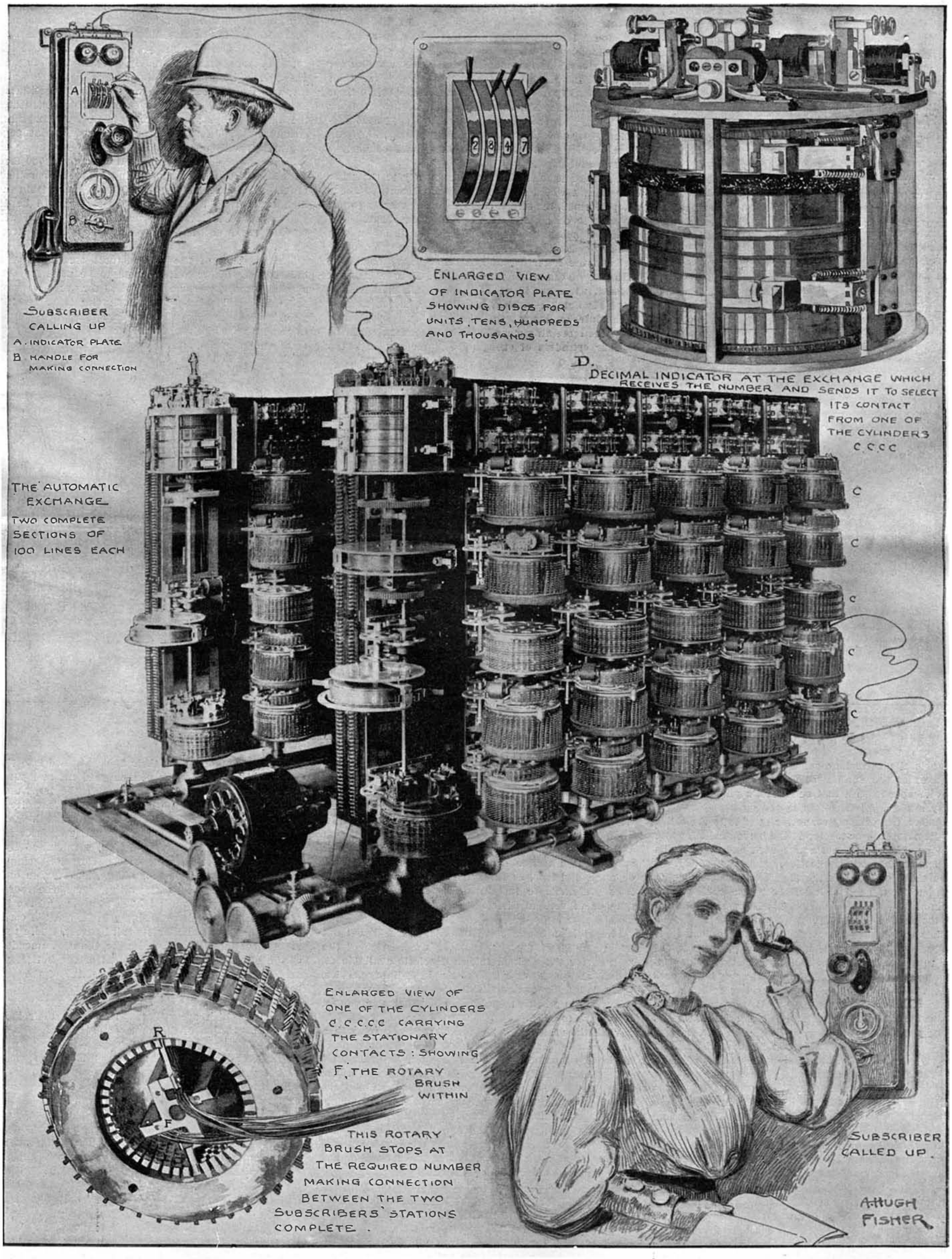
AN AUTOMOBILE SCHOOL.

THE LORIMER AUTOMATIC TELEPHONE.

Two Americans, the Lorimer brothers, have offered to the French government an automatic telephone system of their own invention. The apparatus will soon be put to the test of regular service at a telephone exchange and its adoption or rejection will depend upon its performance. As the apparatus is very complicated an explanation of its action and its advantages will be given without any minute description.

The apparatus now in Paris is designed for an exchange having not more than 200 subscribers, half of whom are connected with each section of the apparatus. Communication between two subscribers connected with one section is established entirely within that section, while communication between subscribers of different sections calls into action four pieces of apparatus of the sender's section and one of the receiver's. In the illustration these two sections, each designed for 100 subscribers, are shown in the central figure. An electric motor, shown at the lower left of this figure, drives a horizontal arbor which lies between the sections and extends throughout their length. This arbor drives a series of vertical spindles, each of which gives motion, as required, to its column of superposed disks or drums. For throwing the parts of this complex apparatus in and out of gear mechanical devices have been used, as far as possible, in preference to electrical ones.

Current for the subscribers' instruments as well as for those of the exchange is furnished by accumulators


A
B
SUBSCRIBER CALLING UP
A. INDICATOR PLATE
B HANDLE FOR MAKING CONNECTION
ENLARGED VIEW OF INDICATOR PLATE SHOWING DISCS FOR UNITS, TENS, HUNDREDS AND THOUSANDS
D.
DECIMAL INDICATOR AT THE EXCHANGE WHICH RECEIVES THE NUMBER AND SENDS IT TO SELECT ITS CONTACT FROM ONE OF THE CYLINDERS C C C C
THE AUTOMATIC EXCHANGE
TWO COMPLETE SECTIONS OF 100 LINES EACH
C
C
C
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C
ENLARGED VIEW OF ONE OF THE CYLINDERS C C C C C CARRYING THE STATIONARY CONTACTS: SHOWING F, THE ROTARY BRUSH WITHIN
R
F
THIS ROTARY BRUSH STOPS AT THE REQUIRED NUMBER MAKING CONNECTION BETWEEN THE TWO SUBSCRIBERS' STATIONS COMPLETE.
SUBSCRIBER CALLED UP.
A. HUGH FISHER.

By courtesy of Illustrated London News

THE LORIMER AUTOMATIC TELEPHONE.

at the exchange—an improvement which does away with individual batteries and magneto-calls.

On the left of each of the two sections is seen an apparatus called a decimal indicator, which serves to identify the subscribers. It consists of a number of superposed circles of contact pieces. Each subscriber's wire is connected with one of these contact pieces.

In the axis of the column of circles is a rotating spindle carrying contact brushes which transmit the subscriber's calls to the other parts of the apparatus. As soon as the call is made the brushes stop, the number is transmitted and the brushes resume their rotation. The sole function of the decimal indicator is to call the other parts of the apparatus into action as they are required. This ideal telephone girl instantly transmits every order and at once turns to her other patrons, all of whom she visits every three seconds in search of fresh commands. Meanwhile, what becomes of the call—that is to say, the number of the subscriber called up?

By various stages it is transmitted to the auxiliary organs of the section, which is composed of exactly similar divisions whose number depends on the volume of communication. Each of these divisions consists of five cylinders, *C C C C C*, alike in appearance but unlike in function.

The topmost cylinder, called the primary connector, represents the plug of the calling subscriber which the operator inserts in the switchboard. It receives the number from the decimal indicator, the division starter (the single cylinder at the lower left), and the controller of the decimal distributor (the circle of contacts on the same axis with the indicator). The units of the number are received in the interior of the primary connector, the tens by the distributor placed above it.

The cylinder immediately under the primary connector is the secondary connector which receives in like manner the number of the subscriber called up, and corresponds with that subscriber's plug in the ordinary system.

In short, the primary connector attends to the caller and the secondary connector to the person called, while the connection between the two instruments puts the two persons into communication.

The third cylinder is the signal transmitter which sends back to the caller electrical impulses which cause a pointer on a dial attached to his instrument to indicate the number called up.

Below this is the interconnector which indicates the hundreds and thousands and therefore the section (of 100) to which the person called up belongs. The interconnector always stands at 00 if the number of subscribers is less than 100. The lowermost cylinder is a rotary commutator, which controls the relays that stop and start various parts of the mechanism at the proper moments.

In the apparatus shown in the illustration each of the two sections contains five of these vertical divisions, each of which is composed of five cylinders. Five divisions usually suffice for 99 subscribers. If the communications are very numerous one or more supplementary divisions may be added without disarranging the section.

The subscriber's instrument contains, in addition to the usual transmitter, receiver, and call bells, an indicator with four disks, for units, tens, hundreds, and thousands. By depressing the handle of each disk to the proper degree the desired number is caused to appear, as shown in the illustration. Then a quarter turn of the handle below sends the call and causes the pointer surrounded by a circle of metal buttons, which is shown just above the handle, to move from the position of communication to the next, or calling button. After from one to four seconds the pointer is seen to move over all the other buttons, making a complete revolution and returning to the position of communication. During this movement the number called for has been transmitted to the exchange. The pointer is controlled by the signal transmitter at the exchange, as has already been stated.

Having thus sent his call the subscriber takes down his receiver, applies it to his ear and presses a button which rings the bell of the person called up. The sound of the bell is heard in the caller's receiver and indicates that the communication is established. Failure to hear the bell indicates that the line is not free. In this case the receiver is hung up and the call is repeated a few minutes later. The whole operation is very simple.

Subscribers' instruments of this character suffice for all cases in which the exchange serves fewer than 10,000 subscribers. If there are more than 10,000 lines the subscriber's instrument has an additional lever which indicates the particular exchange (of 10,000 subscribers) to which the person called belongs, and puts at the caller's disposal an auxiliary wire connecting the two exchanges.

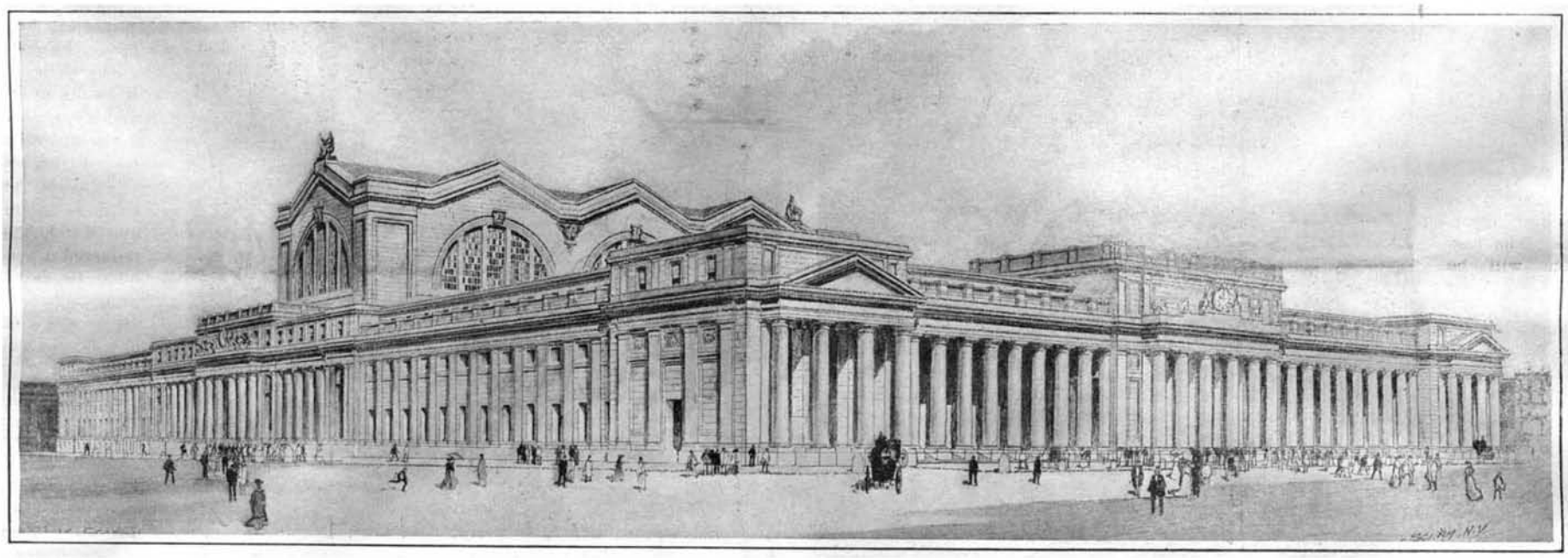
The caller is thus switched temporarily to the other exchange at which all the operations described above are performed, his own exchange serving merely to put his wire in connection with the other exchange.

Thus a subscriber of exchange K, wishing to talk to a subscriber of exchange W, turns his supplementary lever to the letter W, and is immediately connected with one of the wires running from K to W (unless all such wires are in use). Then, when he has indicated his number—which, in this case, is the number of the inter-exchange wire which has been assigned to him—the remaining steps in the transmission are made by four cylinders of exchange W, precisely as if the call had come from a subscriber of that exchange.

It may happen that the apparatus of the exchange is overwhelmed with demands. In that case the calls are stored up and are transmitted, without the necessity of repeating them, as the divisions become free. This delay will be avoided if the apparatus comprises a sufficient number of divisions. It has already been stated that a section can be extended, by adding one or more divisions, as links are added to a chain, but it is preferable to install, at the outset, a sufficient number of vertical divisions to meet all probable demands.

If a division becomes out of order it can be cut out and repaired without interrupting the service of the section, for the decimal indicator selects available divisions and passes over the others. In ordinary service, too, this intelligent and silent foreman judiciously distributes the work among his subordinates, giving a fair share to each.

With the system now in use a break occurring in a subscriber's wire is not detected until an attempt is made to communicate, and then hours or even days may elapse before the wire is repaired. With the Lorimer system, on the contrary, any defect in a circuit is instantly indicated at the exchange by the ringing of a bell and the flashing of two lamps corresponding to the section and division to which the damaged wire is attached. Linemen are at once sent out and the break may be repaired before the subscriber has had occasion to know of its existence.



The façades extend 430 feet north and south and 780 feet east and west.

THE PENNSYLVANIA RAILROAD STATION, NEW YORK, AS SEEN FROM THE SOUTHEAST.

PENNSYLVANIA RAILROAD'S TERMINAL STATION, NEW YORK CITY.

The excavation for the new Pennsylvania terminal station has a total width of about 500 feet and an extreme length of slightly over 2,000 feet. Roughly, it includes four large city blocks, with some additional space which has been included for the accommodation of a power plant and the tunnel approaches to the station. The site is bounded by Seventh Avenue on the east, Ninth Avenue on the west, and on the north and south respectively by Thirty-third and Thirty-first Streets. The whole of this area will be covered at the lower level by the station tracks. At the easterly end, the tracks will converge from twenty-one to four, and they will extend beneath New York city, two of the tracks below Thirty-second and two below Thirty-first Street, ultimately passing under the East River to Long Island City. At the westerly end, the tracks will converge to two tracks, which will pass beneath the North River in two separate steel-and-concrete tubes.

From what has been said above, it will be seen that the site of the station and yard is bisected by two important thoroughfares, namely, Eighth Avenue and Thirty-second Street. Eighth Avenue divides the site into two equal portions, the westerly half constituting the station yard, while the easterly half constitutes the station proper; and here it is that the imposing structure which forms the subject of our front page engravings will be erected. It will have a frontage on the avenues of 430 feet, and on the streets of 780 feet, the sides of the building forming a perfect parallelogram. Below the surface of the street, and within the area covered by the building, the station will be divided into three levels, on the lowest of which will be the tracks at a depth of 40 feet below street grade.

The question of the architectural treatment of a building of this magnitude, and to be used for this special purpose, was one that called for the most careful consideration, and New York city is to be congratulated on the fact that the Pennsylvania Railroad Company were willing to forego the opportunity to erect a huge office building above the station site, and preferred to memorialize their final entrance into New York city by the erection of a magnificent and purely classic structure, commensurate with the importance of the company and the dignity of the great city in which it has at length found a fitting terminal.

The architectural design of the entire exterior is a Doric colonnade 35 feet in height, surmounted by a low attic, the total height of the elevation being 60 feet. In the center of the building, however, in order to accommodate the great waiting room, the roof of the structure reaches a height of 150 feet, and the line of the building is also pleasingly broken at the corner of Eighth Avenue and Thirty-third Street, where there is an elevation of four stories for the accommodation of the offices. The unusual extent of the building in area and its general type are suggestive of the great baths of ancient Rome; in fact, the architects of the building, McKim, Meade & White, took the baths of Caracalla, which are still magnificent in their ruins, as the inspiration of this architectural plan. The dignity and beauty of the building are enhanced by the contrast of the lofty "skyscraper" buildings of the vicinity; and when the structure is completed, the eye will turn with a sense of relief from the exaggerated perpendicular lines of the modern office building to the long, low perspective of this station, relieved at its mid-length by the lofty walls and roof of the waiting room. The exterior construction is to be of pink Milford granite, similar to the building stone of the Boston Public Library and the University Club in New York. This is a particularly effective structural stone, and its soft shades of color are decidedly pleasing to the eye.

The main entrance to the station for foot passengers will be at the center of the Seventh Avenue façade and opposite the intersected end of Thirty-second Street. Once inside the building the passenger will

find himself in a noble arcade, 45 feet in width and 225 feet in length. On either side will be shops where will be displayed wares suitable to the needs of the traveler. At the further end of the arcade the intending traveler will pass the entrance to two large restaurants, one to the left, the other to the right, and will then find himself at the head of a broad flight of stairs leading down to the floor of the general waiting room. This vast hall, the largest of its kind in the world, will be 110 feet in width, 320 feet in length, and will have a clear height from floor to ceiling of 150 feet. Within its spacious walls will be located ticket offices, parcel rooms, telegraph and telephone offices, and baggage checking windows, all so disposed that a passenger may proceed from one to the other in their logical order. Adjoining the general waiting room on the west will be two subsidiary waiting rooms, corresponding in their relation to the main hall to the two restaurants. Each waiting room will measure 58 x 100 feet. One of these is reserved for men, the other for women, and each will be provided with every convenience for comfort. The entrances for carriages will be by way of pavilions located at the corners of Thirty-first and Thirty-third Streets and Seventh Avenue. The carriages will descend on a slight gradient until they reach the level of the station proper. Entrance will be had by the Thirty-first Street incline, and the carriages will leave by the Thirty-third Street ascent as an exit.

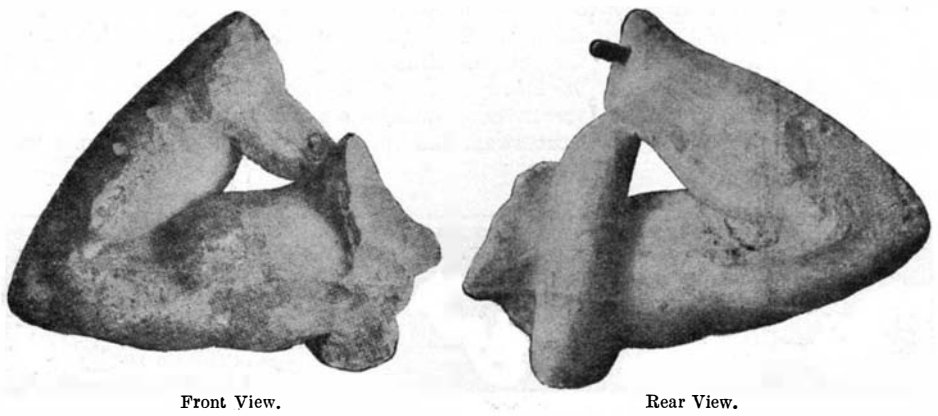
To the east of the general waiting room is the main baggage room with its 450 feet of frontage. The baggage will be delivered and taken away by a special subway, 30 feet wide, which will extend under and along the entire length of Thirty-first Street and Seventh and Eighth Avenues. From the baggage room trunks will be taken to the tracks below by motor trucks and elevators. Cabstands will also occupy this level.

The passenger, after securing his ticket, checking his baggage, etc., passes through between the smaller waiting room entrances onto the great station concourse, an iron-and-steel-covered area over 100 feet wide, which extends across the entire width of the building. Crossing the concourse he will be confronted by a series of gates, bearing signs announcing the destination and time of departure of the trains on the various platforms below at the track level. The concourse and the adjacent areas are open to the tracks, and together they form a great courtyard 340 feet in width by 210 feet broad, roofed in by a lofty trainshed of iron and glass similar in design to the famous trainsheds of the new stations in Frankfort and Dresden, Germany. In addition to the entrances to the concourse from the waiting room, there are also direct approaches from Thirty-first Street, Thirty-third Street, and Eighth Avenue.

Below the main concourse, and located between it and the tracks below, is a sub-concourse, 60 feet in width, which will be used for exit purposes only. From the sub-concourse staircases and inclines will lead to the streets and avenues and to future rapid transit stations under Seventh or Eighth Avenue. Direct connection may also be made, in due time, with the proposed subway station of the Hudson Company's subways running up Sixth Avenue from the North River tunnels of that company. The northern side of the station, paralleling Thirty-third Street, will be assigned to the suburban service of the Long Island Railroad.

The third level, which will be at a depth below the surface of the street corresponding to the height of an ordinary four-story building, will be entirely covered below the station building with twenty-one parallel tracks and their respective platforms. Within the station area, covering 25 acres of ground space, there will be 16 miles of tracks. A trackage area of this amount will afford ample facilities for the easy movement by electric power of the many hundreds of trains per day that will use this station. Through trains from the West, after discharging passengers, will proceed at once to Long Island City, where the main train yard and terminals will be located, thus leaving the station tracks clear of any idle equipment. In like manner, the westbound through trains, which will be made up at the Long Island City terminal, will pass through the station, stopping only to take up their quota of passengers. The suburban service of the Long Island Railroad will be operated on the "shuttle" plan. The planning of the station, with its numerous entrances and exits independent of each other, and separating the incoming from the outgoing throng, was worked out to facilitate, in greatest measure, the prompt and uninterrupted movement of the traffic. The exposure of the building on all four of its sides to main arteries of street traffic gives the plan a flexibility which is rarely obtainable and also insures easy connections by underground subways with the future extensions of the city's rapid transit system.

Following this article on the station building, we shall, next week, illustrate the huge work of excavation, which has to be carried out before the station itself can be erected.



Front View. Rear View.

Fig. 1.—The Newly-Discovered Right Arm of Laocoön Showing Its Correct Position and That of the Serpent's Coils.

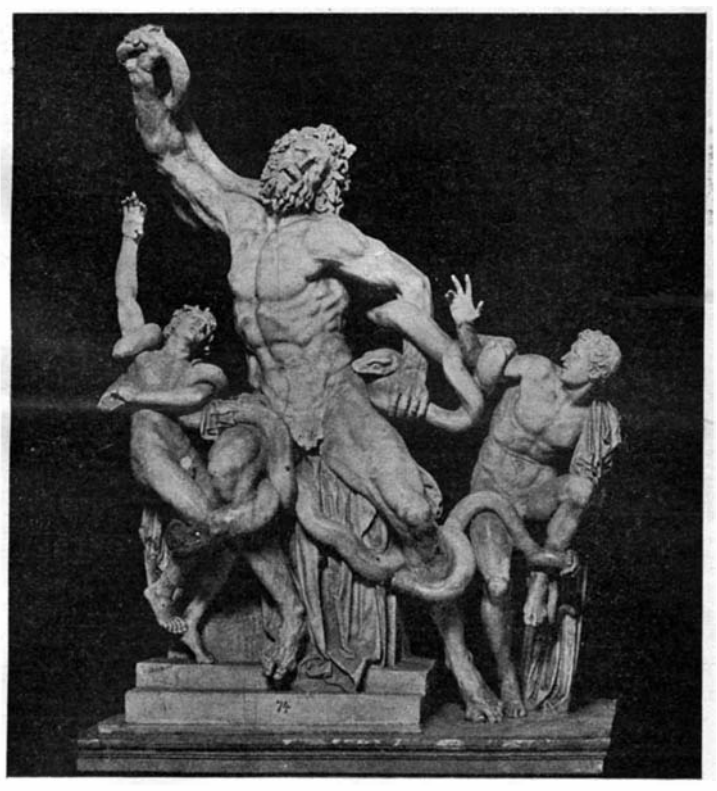


Fig. 2.—The Present Incorrect Restoration of the Laocoön Group.

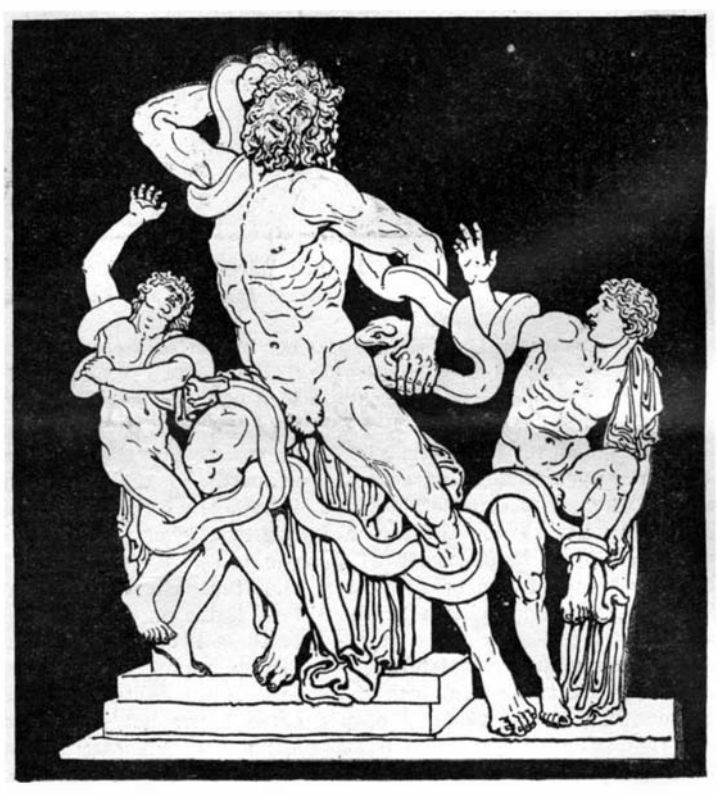


Fig. 3.—A Correct Restoration of the Laocoön Group.

Fig. 4.—The New Reconstruction of the Laocoön Group From the Rear.

THE LAOCOÖN GROUP AS IT OUGHT TO BE.

THE LAOCOÖN GROUP AS IT OUGHT TO BE.

The famous Laocoön group was found in a vault in Rome in 1506. Pope Julius II. bought the statue and placed it in the Vatican. There it remained until Napoleon in 1796 bore it to Paris as a trophy. In 1815 the group was returned to the Vatican.

When the statue was unearthed the right arm of Laocoön and of the younger boy were missing, and likewise the right hand of the older boy. The group was restored by Giovanni Montorsoli. Even in his day some doubt was expressed as to the accuracy of his reconstruction. At the time of its exhibition in Paris Radel expressed the opinion that the right arm of Laocoön could not have been extended high in the air, but that it must have been bent toward the head. According to a recent issue of Umschau, a young German savant, Herr Ludwig Pollak, has been fortunate enough to discover a fragment of an arm which undoubtedly formed part of a replica of the Laocoön group and which has rendered it possible to determine the correct position of the original arm.

The arm, illustrated in Fig. 1, was found by Pollak in a small Roman "scalpellino" among a mass of marble statuary fragments. These fragments are commonly bought, refurbished, and sold. Pollak was informed that the arm had been discovered in the "via Labicana"; no further details were available. He saw that the fragment was the right arm of a Laocoön and bought it. The stone of which the arm is made is a coarse-grained Parian marble. In ancient times it had been broken in two places and repaired. The serpent was injured at the time of the last fracture; but its convolutions can still be traced. The body of the serpent has the smooth surface so characteristic of the restored group. In all probability the scales were painted. At the inner side of the upper arm three indentations are to be seen, which were evidently caused by the pick of some workman.

So different is this fragment from the Vatican group that it could not have belonged to it, but to an ancient replica about one-ninth smaller than the original. The arm was probably broken when the statue was removed from its pedestal in Rhodes and taken to Rome.

The newly-discovered arm renders it possible to correct the restoration. This Pollak has done, as shown in Figs. 3 and 4. The group gains considerably in artistic composition. The uplifted arm of the restoration has the declamatory effect of shallow pathos. By carrying the arm back of the head the suffering of Laocoön is made more intense.

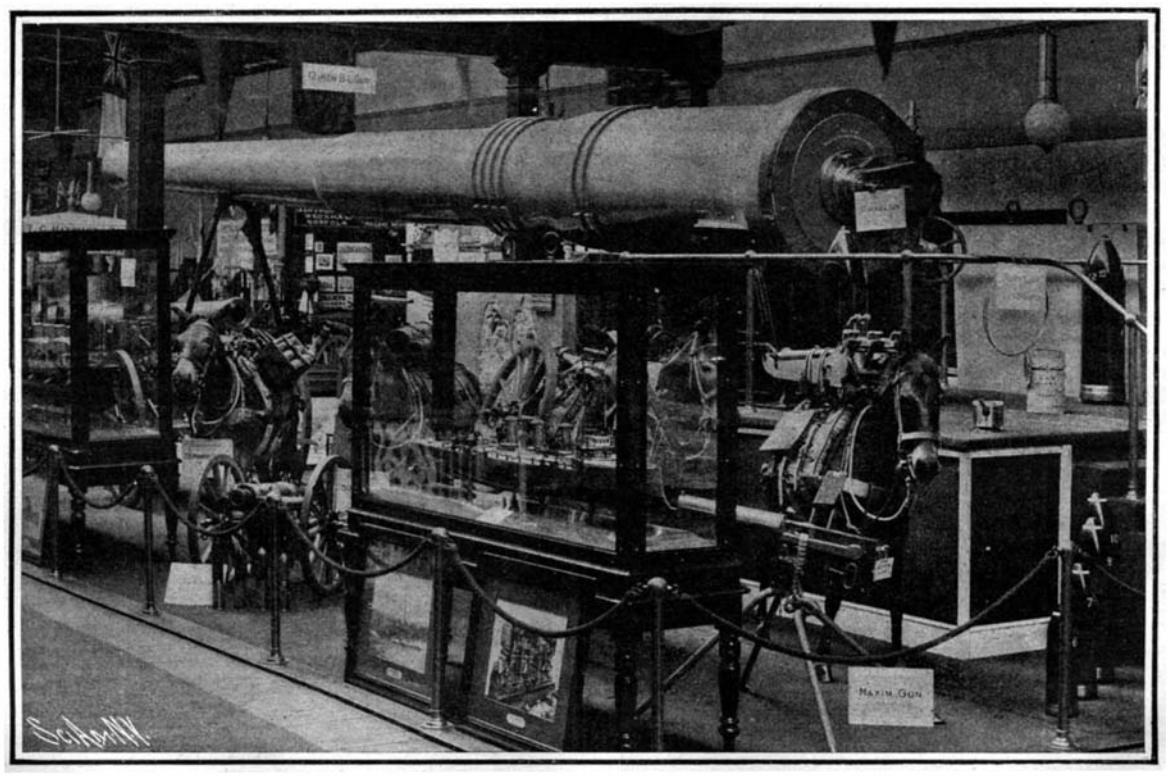
Automobile Show and Carnival.

An open-air automobile show and series of tests of machines will be held at the Empire City race track the last three days of this week. Some of the interesting tests will be an obstacle race, a vibration test (made by carrying a pail of water), and a power test to see which machine will go the farthest through deep sand.

THE NEW VICKERS-MAXIM 12-INCH BREECH-LOADING WIRE-WOUND GUN.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The new type of 12-inch breech-loading wire-wound gun made by Vickers-Maxim, and herewith illustrated, possesses several improvements, notably in the breech operating gear. This gun, which will figure largely in the new cruisers and battleships now being built for the British navy, has a total length of 556.5 inches, which is equivalent to 46.375 calibers, the length of the bore being 540 inches, or 45 calibers, while the shot has a travel of 459 inches, or 38.25 calibers, the length of the projectile chamber thus being 81 inches. At the breech the diameter of the weapon is 5 feet 6 inches, and at the muzzle behind the swell 1 foot 10 inches. The wiring jacket ranges from 80 wires at the breech through gradual reduction to 16 wires at the muzzle. The weapon fires a projectile of 850 pounds with a charge of 310 pounds. The muzzle velocity is 2,850 foot seconds, and the muzzle energy 47,874 foot tons. The powder pressures within the bore of the gun vary from a maximum of 18 tons to the square inch against a circumferential strength of 34.4 tons per square inch at the breech to 7.65 tons to the square inch against a circumferential strength of 16.1 tons to the square inch at the muzzle.



The New Vickers 12-inch Wire-Wound Breech-Loading Gun, Which Fires a Projectile of 850 Pounds. Muzzle Energy, 47,874 Foot Tons. Length, 46.375 Calibers.

This weapon is considerably larger and more powerful than the latest type of 12-inch 50-ton wire-wound gun produced at the British government arsenal at Woolwich. This Mark IX. class is five calibers shorter than the new Vickers production, being only 496.5 inches in length—41.375 calibers—yet the longer weapon is considerably stronger, especially toward the muzzle.

The breech operating mechanism for this latest Vickers 12-inch gun is of a new type, containing several distinctive improvements, whereby a considerable increase in power is obtained when closing the breech. The mechanism is operated by a hand wheel with worm and worm-wheel gear mounted in a bracket carried on the end frame of the gun, as shown in the accompanying illustrations and the gearing is so arranged that to operate the mechanism completely seventeen turns are necessary—12.2 turns to unlock the breech and 4.8 turns to swing it out to fully open position. The Vickers type of breech screw is used, mounted and retained on the stem of the carrier by interrupted screw threads.

In this mechanism a pure "couple" for rotating the breech screw is applied, and the inherent defect of the general type of breech mechanism, wherein the screw is rotated by a turning movement which sets up appreciable friction, due to a tendency to produce axial displacement of the breech screw, is obviated. By the utilization of a couple, the whole of the available turning force applied to the breech screw is employed in seating the obturator, and all possibility of friction from the above-mentioned tendency is completely overcome.

The breech block carries the Welin screw in which the thread is cut in successive steps of decreasing radii. In unlocking the breech it is necessary to rotate it only through as much of arc as equals the length of one step of the thread. This disengages all the threads so that the block can be withdrawn. The advantage of this type is that a minimum amount of the thread has to be cut away, and the breech-block can be proportionately reduced in length and weight. There are two sets of safety slides, one for percussion lock and the other for the electric lock, fitted to the box slide. On opening the breech the percussion striker is automatically fully cocked. A floating needle is arranged so that normally the point of the needle is always within the face of the lock frame. The electric lock is of special design, there being two levers, one on each side of the lock frame, and these are simultaneously operated on the first movement of the lock frame on opening the breech. The arrangement of these two levers is such that there is a small projection round their bosses which trips against the lock slides on the box slides. As the outer ends of these levers act directly on the electric needle, the latter is drawn away almost instantaneously from the lever on the first movement of the unlocking of the breech.

In the event of a miss-fire the lock frame can be drawn away sufficiently to eject the primer without opening the breech, owing to the arrangement of the spring bolts engaging the lock frame with the slide link in the carrier, and the engagement of the slide with the operating cam on the crank.

The extractor is of special design upon new lines. It is of great strength and is made in two parts. The operation of the lock frame acting, because of a fine incline on the first part of the extractor which is the toe, first powerfully wedges out the primer before its rapid ejection by the engagement of the second part of the device which is comprised by the lock of the extractor.

The complete weight of the weapon exclusive of the carriage is 57 tons 8 hundredweight 2 quarters 16 pounds. Its penetrative capacity with capped shot so far as has been ascertained is 24.3 inches through Krupp cemented plate. Further tests with the weapon are, however, to be carried out, when definite data on the point of penetration will be available.

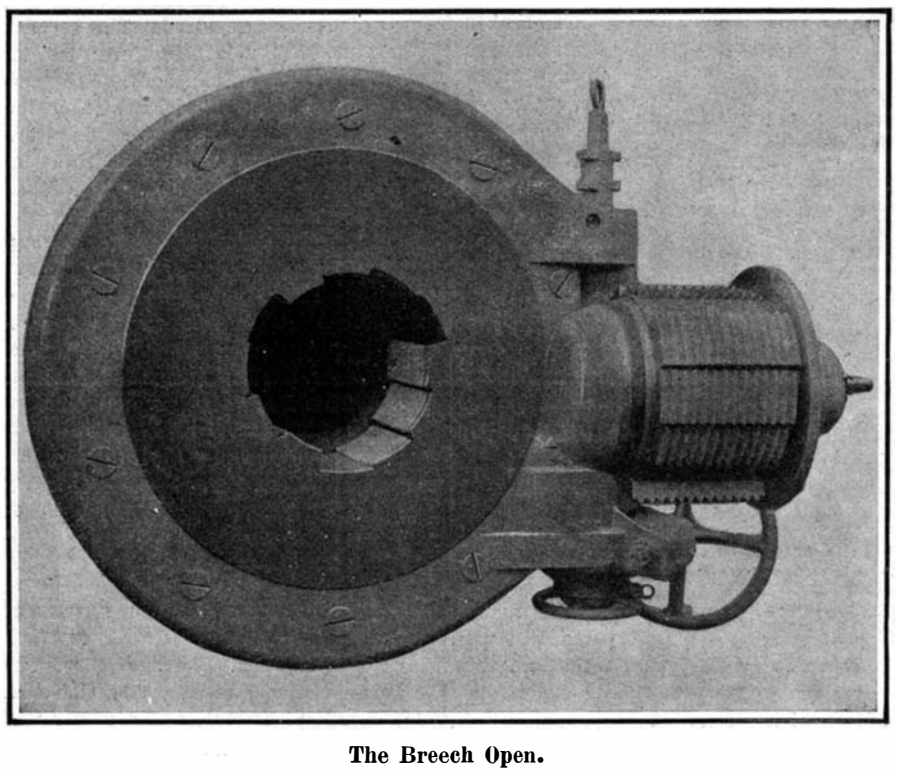
Injection of Trees.

Often the roots of fruit trees, more exhausted than the parts in the air, refuse to supply the branches with their subterranean sustenance. To cure or prolong the life of cases possessing still a certain vigor, recourse was had, says L'Illustration (Paris), of March 17, to powders, then to the injection into the trunk of a solution of sulphate of iron. This last expedient is valuable for treating chlorosis in vines. A Russian entomologist, Mr. Sigismond Monryetsky, wished to ascertain the laws that regulate the penetration of the liquid into the cells of the tree. By employing colored solutions, he proved that the liquid never penetrates into the old wood. It follows the young layers, descending into the roots to the depth of a meter (3¼ feet), and rising to the top of the tree, with a uniform distribution. In consequence, Mr. Monryetsky recommends injection through a single hole made in the neck of the root.

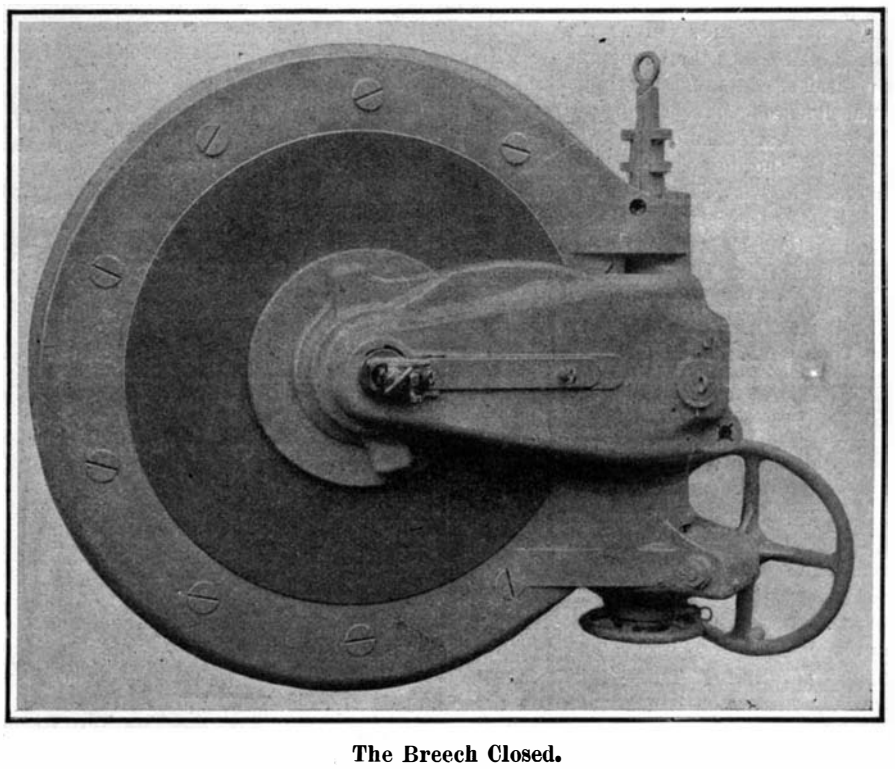
In these conditions, the process seemed applicable not only for injecting nutritive elements into the tree, but besides for curing diseases determined by the presence of a bacterium. The experiments have confirmed the theory, in so far as that disease of stone-fruit trees is concerned, which consists of an efflux of gum through a wound in the bark: plum trees, peach trees, almond trees, etc. Into these weak solutions of oxalic acid, of citric acid, of creosote, or of salicylic acid were injected. The last gave the best results.

Erratum.

In our issue of May 12 we published an article on the Economical Use and Properties of Reinforced Concrete, which we credited to Mr. Charles S. Hill. It seems that our excerpt was taken from a monograph jointly written by Mr. Charles S. Hill and Mr. A. W. Buel. Our excerpt was taken from that part of the monograph which Mr. Buel prepared, and should have been credited to him.



The Breech Open.



The Breech Closed.

THE NEW VICKERS-MAXIM 12-INCH BREECH-LOADING WIRE-WOUND GUN.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

REVERSING-SWITCH. — J. N. ANDERSON, New York, N. Y. This invention relates to reversing-switches and admits of general use, but is of peculiar value in connection with electric elevators and analogous structures in which the general direction of relation is required to be changed at will. Mr. Anderson has produced a switch for the direct control of the operator and capable of running the elevator in two directions, the main circuit being opened and closed very quickly.

Of Interest to Farmers.

PLOW.—J. Q. A. JOHNSTON, Newburyport, Mass. One purpose of this improvement is to provide a rotary plow adapted to be drawn over instead of through the ground, as customary, in the construction of which a rotary holder is employed carrying a number of independently-operating blades arranged in rows, one blade in a row being staggered in relation to the others, whereby the blades have a spading operation on the soil in the operation of the plow.

Of General Interest.

VULCANIZED MATERIAL AND PROCESS FOR MAKING THE SAME.—F. EPHRAIM, San Francisco, Cal. The invention relates to the utilization of crushed or pulverized material naturally found in caoutchouc, rubber, or gum containing plants. The inventor has discovered that instead of removing as an impurity fibrous material already found in the crude rubber and adding the material made of the cotton waste it is much better to work up the crude rubber without subjecting it to the special processes employed for removing the fiber.

METHOD OF EVAPORATING LIQUIDS.—A. P. GEER, New London, Conn. The present invention relates to a method of evaporating liquids in general, and especially for evaporating salt water and condensing the vapors for the production of water fit for use in the boilers of marine vessels and other purposes. The principal object is to improve the method so as to secure a proper evaporation of the salt water without danger of clogging the apparatus or of rendering the same ineffective.

NON-REFILLABLE BOTTLE.—E. K. WOOD, San Francisco, Cal. The devices for preventing refilling of the bottle are secured in the neck of the bottle by means of a packing-ring, seated in a groove in the neck and securing the devices with a lower cross-plate bearing against an outwardly facing shoulder. Sufficient room is left within the devices to receive an ordinary cork in order to securely close the neck of the bottle.

RANGE-FINDER. — H. C. PERCY, Natchitoches, La. In the operation of this range-finder it will be found that the sides of the imaginary triangle will be proportionate to the sides of the triangle of the table and that the base of the table-triangle will be to the measured base-line as the sides of the table-triangle are to the distance of the object from the ends of the measured base-line. By a provision of verniers a much closer reading may be obtained than by use of indicators.

OIL-PRESS MAT.—R. F. WERK, New Orleans, La. The aim in the present invention is to produce an animal-hair mat which will operate to secure a large yield of oil by reason of its superior draining qualities and which will develop through use a smooth glossy surface that is very advantageous because the surface facilitates operation of charging the formed cake into the press, and the cake will not adhere to the mat, with the result that the mat can be stripped with ease and facility. Subject-matter of the invention forms a division of a prior application for Letters Patent formerly filed by Mr. Werk.

SKIRT-SUPPORTER.—LUCY A. PHILLIPS, Lucca, N. D. In this case the invention refers to improvements in supporters for dress-skirts, the object being to provide a supporter of novel and inexpensive construction that may be permanently attached to a corset or like garment and that will firmly hold the skirt in place or closely against the back of the wearer.

FORM FOR TROUSERS.—ALICE JONES, Dehesa, Cal. The invention relates to a device for preserving the shape or form of trousers when pressed. It is also adapted to be used for the purpose of facilitating the pressing of the trousers. The device is easily applied, and can be folded up with the trousers when in position in the same, so as to be placed in a drawer or in a trunk.

IMPLEMENT FOR CLEANING RECEPTACLES.—P. H. TALLMAN, Blooming Prairie, Minn. This implement is for use in cleaning interior surfaces of milk-cans and other receptacles formed of tin-plate, glass, or similar materials. The can should receive a supply of detergent liquid that along with the scrubbing movement of the implement will thoroughly cleanse the inside surface of the vessel, the shape of the brushes adapting them to have contact with all parts thereof if handle rods and attached brushes are reciprocated longitudinally in the can and simultaneously rotated therein.

AWNING.—C. W. RUSSELL, Louisville, Ky. The object of the inventor is to provide an awning arranged for convenient application to a window, door, vehicle, or other device and adapted to be closed and folded to take up comparatively little space. It can be readily set up by simply fastening the post in front of the window at or near the middle. By moving the runner up or down the awning can be conveniently extended for shading or folded for spacing.

EXTENSION AND OTHER TABLE.—R. L. RICHARDSON, Keota, Iowa. A plurality of side sections is employed for the top-frame of the extension-table or for a non-extension table, said sections being formed of plate metal and each provided with longitudinally-extending tubulation which is open at one side, but exceeds a half-circle in cross-section, whereby said frame-sections are adapted for telescopic connection in sequence and when so engaged are prevented from lateral disengagement.

INDICATOR FOR BOTTLES.—F. A. FRKOVIC, Galveston, Texas. The object of this invention is to provide means for plainly indicating when the original contents of a bottle have been removed and also to register the amount of liquid removed and that remaining in the bottle as the contents are from time to time partially decanted therefrom; and a further object is to provide means for displaying within the bottle a trade-mark or label which cannot be tampered with.

AWNING.—F. A. LEARNED, Chicago, Ill. This invention is an improvement in awnings. It is simple in construction, efficient in operation, and will not easily get out of order. The action of the ropes in extending the side arms is positive and is not dependent upon springs or weights, thus insuring always a proper extension of the arms.

IRRIGATION-DAM. — A. W. APPLEGATE, Brawley, Cal. In this patent the invention has reference to improvements in dams for land irrigation, and it is the object of the inventor to provide a weir board or gate that will open by water-pressure when the water reaches a predetermined level, thus dispensing with an assistant and lessening the danger of washouts.

CALCULATOR.—K. H. J. MARCKWORDT, Guatemala, Guatemala. In this instance the invention relates to registers. The object is to provide a calculator more especially designed for conveniently and accurately carrying out arithmetical calculations, such as calculating wages, volumes, multiplication, degrees of alcohol, lumber measures, degrees of sugar polarization and the like.

CASING-BOWL.—W. H. KESSELMAN, Parkersburg, West Va. It is the principal object of this inventor to provide a packing so that the water can be shut off from the inside of the casing and boiled out to enable the tools to get the full force of the blow in jarring. In bowls as now constructed there is a conical surface which is subjected to a great deal of wear in use. Another object is to cushion this surface and to provide for its ready removal and renewal.

NON-REFILLABLE BOTTLE.—J. DE HAVEN, Roanoke, Va. The device is simple, and little change is required from the ordinary form of bottle. The neck is of sufficient diameter above the shoulders to permit the ready passage of fluid by the valve, the part of the neck above the shoulders being slightly funnel or cone shaped in order that the parts may be readily introduced.

FIELD OR HUNTING FLASK.—R. BURGER and A. ASCHENBRENNER, Berlin, Germany. This flask is for use in storing liquids, more particularly beverages. It is provided with a protective jacket. A layer of heat-insulating material is arranged between the two glass walls to prevent breaking of the glass by concussions or the like, at the neck of the bottle. The practical value of the invention consists in the liquid remaining in the bottle at the same temperature for many hours. Hot coffee or milk can be kept hot from morning till evening.

CULVERT CONSTRUCTION.—H. BESSER, Alpena, Mich. The principal objects of this inventor are to provide means whereby sewer-pipes and culvert constructions can be laid in place after manufacture elsewhere without necessitating the handling of the heavy sections now usually employed; furthermore, to provide means for strengthening constructions of this character and to provide for forming joints which will be capable of being made tight and of such nature that pressure upon their exterior surfaces will not operate to loosen them.

Hardware.

GRIP.—J. DUNBAR, Invercargill, New Zealand. The improvement is applicable to such tools as rakes, hoes, spades, and forks, and has for its object a means to connect the handles of rakes and hoes with the heads of such tools, enabling a broken handle to be easily replaced and the heads of same adjusted to different angles, extending their scope of usefulness, and in respect to spades and forks provides a means to connect a hand cross-piece with the shanks of these instruments to form a handle-grip.

KEY-FASTENER.—L. A. FOSTER, Lagrange, Ind. This improvement has for its object the provision of a novel construction by which to prevent a key when in a lock from being turned by means of nippers or the like from the opposite side of a door. The construction renders the cheapest locks as fully burglar-proof as the most expensive one.

Heating and Lighting.

CUPOLA.—J. H. KOONS, Delphos, Ohio. The invention pertains particularly to heaters for cupolas or furnaces in which hydrocarbon oil is used as the fuel, the object being to provide a device of this character by means of which the oil mixed with air or steam will be caused to enter the cupola under a high degree of heat, resulting in an intense and practically even heat from an economical supply of burning fuel.

HEATING SYSTEM.—F. SHURTLEFF, Moline, Ill. The invention relates to steam-heating systems, and particularly to that class known as "vacuum." The object is to provide an apparatus free from former defects and characterized by improved means for venting the air from the radiators by ejecting devices all located at one point and discharging such air outside the building or rooms and for sealing the system against return of the air.

Household Utilities.

IRONING-BOARD SUPPORT.—C. SCHAFER, Violetville, Md. In this instance the invention is an improvement in supports for ironing-boards adapted for application to an ordinary table or shelf to support any ordinary ironing-board, the construction being designed for sale independent of ironing-boards and to receive an ironing-board ordinarily in the possession of householders.

WINDOW-SCREEN.—G. D. MONCRIEF, Memphis, Tenn. The aim of this inventor is to provide a single sash-screen hanger which can be conveniently applied for use, easily opened for any desired purpose, and may be fastened in position for use. The screen may be readily unlatched and thrown out at the lower edge for the purpose of dusting or cleaning and quickly readjusted to position for use.

Machines and Mechanical Devices.

ANIMAL-RELEASING MECHANISM.—J. A. TAYLOR, Saco, Mont. The invention pertains particularly to improvements in means for releasing horses from their stalls in case of fire or other accident in the barn or stable, the object being to provide a simple means adapted to be operated from the outer side of a barn or stable, whereby the several horses that may be in a row of stalls can be simultaneously released.

MOLD-RAMMING MACHINE.—J. POULSON, Phillipsburg, N. J. One of the principal objects of this invention is to provide for reciprocating a series of rammers so that they will be picked up by the reciprocating device and elevated to desired height and that when forced against sand in the mold the rammers will be shortened, or in other words, distance between the lifting means and the bits of the rammers will be decreased, so that as the sand rises in the mold the rammers will be in such condition that they will at all times give a strong blow upon the top of the sand and ram the sand with evenness throughout the length of the mold.

GAS-WELL APPARATUS.—F. J. MOSER, Kane, Pa. The invention relates to deep wells, more particularly used for supplying natural gas, the special object being to provide means for removing water from the bottom of the well. The operator removes water at intervals as desired without obstructing the flow of gas from the well or interfering with the perfect working of the well or any part of it. Water is removed utterly independent of normal action of the well for purposes of supplying gas. Water is temporarily cared for that may drift into the well by storing it in a reservoir, so that it produces only a minimum of hardship.

CALCULATOR.—F. W. BENNETT, Waterbury, Conn. In this patent the invention relates to an apparatus by means of which mathematical calculations—such as addition, multiplication, subtraction, and division—may be performed mechanically. The underlying object is to simplify the parts of the machine and to enable the calculations to be performed by less movements and in shorter time than heretofore.

MACHINE FOR DIPPING TOBACCO.—R. BAILEY, Winston Salem, N. C. A vat or tank is provided, in which is arranged a peculiarly-constructed drum coacting with an endless apron, the latter receiving the tobacco from a feed-hopper and running under the drum, so as to carry the tobacco into the liquid contained in the tank, after which the tobacco is carried from the tank by the apron and passed with the apron through squeezing rollers or devices, which eliminate superfluous liquid, the tobacco being discharged from the machine by a scraper or other means coacting with the apron.

Prime Movers and Their Accessories.

INTERNAL-COMBUSTION ENGINE. — D. MCR. LIVINGSTON, New York, N. Y. The object of this invention, which relates to a two-cycle internal-combustion engine, is to provide a valveless engine in the cycle of which there will be maintained a stratification of scavenging-air and fuel, so that after each explosion a volume of scavenging-air will be blown through the cylinder, cooling and cleansing the same, and will be followed by the fuel charge, which will then be compressed and ignited in the usual or any desired manner.

EXPLOSION-TURBINE.—A. L. MOSS, Sandusky, Ohio. In this patent the intention of Mr. Moss is to provide a new and improved explosion-turbine in which impact impulses are given in quick succession to the turbine-wheel at different points of its periphery to insure a uniform and powerful running of the turbine.

Railways and Their Accessories.

CAR-FENDER.—J. A. SAGE, Stryker, Ohio. There is provision in this invention for a device which will effectually prevent the car from running down and injuring persons and one which automatically adjusts itself to all curves in the railway-track. The invention relates to an improvement in fenders for cars, and more particularly for trolley and cable cars.

CAR-FENDER.—J. C. JORGENSEN, Washington, D. C. A simple pressure of motorman's foot throws the brake-shaft into gear with the means for depressing the fender, and a quarter-turn of the shaft will lower the front of the fender into contact with the track, and may be maintained in firm contact with the track so that nothing passes under it until released from the shaft. Lowered with car moving at full speed, it strikes a person standing on the track at the bottom of the feet, forcing them outwardly and causing such person to fall back into the netting.

TRACK-SANDING DEVICE. — F. BASON, Chicago, Ill. One purpose here is to provide means for admitting atmospheric air, hot or cold, to the sand at or near the base of the sand receiver for the purpose of relieving from vacuum the compressed air employed, which compressed air forces the sand and atmospheric air to the ejector, said sand and atmospheric air being drawn properly commingled from sources of supply, due to the passage of the compressed air through the device, to its discharge portion.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

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Inquiry No. 8108.—Name and address of manufacturers of American Diamond Light Oil Burner.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 8109.—For manufacturers of the Graham Safety Lamp Filler.

For bridge erecting engines. J. S. Mundy, Newark, N. J.

Inquiry No. 8110.—For manufacturers of overshot water wheel.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St. Chagrin Falls, O.

Inquiry No. 8111.—For manufacturers of the Gilbert heel cushion; also Eagle Claw fish trap.

FOR SALE.—Patent pipe leak stopper; all sizes, any pressure, very simple. Hanson, 16 E. 84th St., City.

Inquiry No. 8112.—For manufacturers of compressed air meters.

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Well gotten up typewritten letters will increase your business. $2 per 1.000.

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The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company. Foot of East 138th Street, New York.

Inquiry No. 8115.—For manufacturers of machines for making straw brooms and root brushes.

Models and Experimental Work, Electrical and Mechanical Devices, Small Machinery. J. Lenz, 310 Hudson Street, New York.

Inquiry No. 8116.—For manufacturers of the magnetic compass, such as is used in watch charms.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery tools, and wood fiber products. Quadriga Manufacturing Company, 18 South Canal St., Chicago.

Inquiry No. 8117.—For manufacturers of rubber goods, such as tubing, hot water bottles, etc.

WANTED.—To purchase or hire a second-hand steam roller, about 7 tons, for the building of Macadam roads in Worcester County, Md. Applications should be sent to J. Edward White, County Treasurer, Snow Hill, Md.

Inquiry No. 8118.—For manufacturers of animated toys, such as men, etc.

Automobile experts are in constant demand at high salaries. Our seven weeks' course is the most thorough and practical, fitting men to drive, handle and repair. Day and evening classes. Special course for owners. New York School of Automobile Engineers, 146 West 56th Street, New York.

Inquiry No. 8119.—Wanted, address of Paris or United States manufacturer of reconstructed rubies and emeralds.

WANTED.—The partial services of several men who have facilities for observing, and ability to comprehend the performance and good features of different automobiles. The work will occupy little time, and be chiefly in the nature of correspondence. Address Thomas B. Jeffery & Company, Kenosha, Wis. Department of Construction.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

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Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(9979) D. C. asks: 1. It seems feasible, and I understand, perhaps erroneously, how nitro-glycerine or other compound of nitrogen, which has such a feeble grip on other elements, could readily by detonation be transformed into gas which would violently compress the atmosphere and cut and tear things to pieces; but how a proportional composition of hydrogen and oxygen, the former the lightest of all gases, could compress the air or cause an explosion at all is a mystery to me, unless there is an outward explosion, from solid matter to gas, such as that by dynamite, gun-cotton, or gunpowder, and an inward explosion, gas exploded by flame partly consumed, thereby causing a vacuum and violent rush of air to fill the place occupied by the gas consumed. Is it the air or gas that does the damage, cuts and tears the material to pieces? Whichever it is, it must become sharp as a razor and hard as steel. Why is there such a deafening report when only in contact with air? A. In the explosion of a solid, such as gun-powder or nitro-glycerine, the substance is transformed into gas at an enormously high temperature, which causes a very great pressure and force of expansion, thus rending the walls of the containing receptacle, and hurling the fragments to a great distance. In the case of the explosion of mixed oxygen and hydrogen the same result is reached. The heat of the resulting steam causes a great expansion and rending of the vessel in which the combustion takes place. 2. Some time ago I read in a magazine that the coal measures or carboniferous beds in Ireland were pushed into the Atlantic Ocean by the ice at the time of the Glacial Period. Is this generally accepted as true by geologists, and if so have they any means of knowing whether the beds were composed of anthracite or bituminous coal? I am aware that the coal fields near Castlecomer, Ireland, are anthracite, and I heard there were small bituminous fields in other parts of the island. Can you inform me if this is the case? A. We have no detailed information regarding the displacement of the coal measures in Ireland. The textbooks of geology state a belief that once coal measures covered the subcarboniferous limestone of the center and southwestern part of the island. You may perhaps obtain help in this matter from the professor of geology in the university of your city. Such men are always willing to give information to inquirers.

(9980) F. W. B. says: My boat is 20 feet long by 4 feet 5 inches wide, with easy lines, and my engine is supposed to be a high-speed double-cylinder opposed-motor, bore 4 inches, stroke 4 inches, weight less than 200 pounds. It is said to give 4 horse-power at 500 R. P. M., and I would like to know what size propeller you would advise me to use, and what should be the proper pitch, and whether it should be two fluke or three. A. The size of a screw depends upon so many things, that it is very difficult to lay down any rules for guidance. However, the following rules are given sometimes for ordinary cases, where the size and power of the boat does not exceed a speed of 20 knots per hour. First: The "pitch" of a propeller is the distance which any point in a blade, describing a helix, will travel in the direction of the axis during one revolution, the point being assumed to move around the axis. The pitch of a propeller with a uniform pitch is equal to the distance a propeller will advance during one revolution, provided there is no slip. In a case of this kind, the term "pitch" is analogous to the term "pitch of the thread" of an ordinary threaded screw. Let P = pitch of propeller in feet. Then

$$P = \frac{10133\,S}{R(100-x)}$$

In which S = speed of boat in knots, R = revolutions per minute of propeller, x = percentage of slip. Assuming a speed of 10 knots per hour for your boat, with engine running at 500 R. P. M., and assuming a 10 per cent slip, we get a pitch of

$$P = \frac{10133 \times 10}{500(100-10)} = 2.25 \text{ feet.}$$

This is probably high, due to the fact that we assumed a low percentage of slip.

Diameter of propeller =

$$K\sqrt{\frac{I.\,H.\,P.}{\left(\frac{R \times P}{100}\right)^3}}$$

K = constant = 17.5. I. H. P. = 4. R = 500 R. P. M. P = 2.25. Therefore, diameter of propeller under these conditions, namely, four blades to the screw, made of cast iron, would be approximately one foot diameter. To allow for any increased slip which may occur, and other contingencies which may arise, we would not advise a screw less than 2 feet in diameter, calculated on a pitch of 2 feet. This will easily allow for any increased speed desired over 10 knots up to 15 knots per hour.

(9981) F. R. S. asks: Some two months ago a friend of mine on a steamer going to Jamaica noticed something which I would like a little information upon. There was an operator on board the steamer for the wireless telegraph. The boat was equipped with its own electric light plant. When a message was being received by the boat from shore the lights in the boat would dim, which would naturally show an overload of current, and there would also be a rumbling sound about the boat at the time of receiving the message. What I cannot understand is why the receiving of the message would affect the lights on the boat, and what would cause the rumbling sound. A. An electric current flowing in a wire is very sensitive to another current in the vicinity, and it is to be expected that wireless signals should impress a current in the vicinity of current for lighting purposes, producing such results as you describe.

(9982) C. J. N. asks how to draw on glass. A. To write or draw on glass, it is necessary to impart to the surface a certain degree of roughness. This may be done by grinding or etching, but much more easily by applying some appropriate varnish. A good matt varnish is made by dissolving in 2 ounces of ether, 90 grammes of sandarac and 20 grammes mastic, and adding benzol ½ ounce to 1½ ounces, according to the fineness of the matt required. The varnish is applied to the cold plate after it has set. The glass may be heated to insure a firm and even grain. To render the glass again transparent, after writing upon it, apply with a brush a solution of sugar or gum acacia. Still better as a surface for writing or drawing is a varnish of sugar. Dissolve equal parts of white and brown sugar in water to a thin syrup, add alcohol, and apply to hot glass plates. The film dries very rapidly, and furnishes a surface on which it is perfectly easy to write with pen or pencil. The best ink to use is India ink, with sugar added. The drawing can be made permanent by varnishing with a lac or mastic varnish.

(9983) J. N. B. asks how to prepare sheepskins for mats. A. Make a strong lather with hot water and let it stand till cold; then wash the skin in it, carefully squeezing out all the dirt from the wool; wash it in cold water till all the soap is taken out. Dissolve 1 pound each of salt and alum in 2 gallons of hot water, and put the skin into a tub sufficient to cover it; let it soak for twelve hours, and hang it over a pole to drain. When well drained stretch it carefully on a board to dry, and stretch several times while drying. Before it is quite dry, sprinkle on the flesh side 1 ounce each of finely pulverized alum and saltpeter, rubbing it in well. Try if the wool be firm on the skin; if not, let it remain a day or two, then rub again with alum; fold the flesh sides together and hang in the shade for two or three days, turning them over each day till quite dry. Scrape the flesh side with a blunt knife and rub it with pumice or rotten stone.

(9984) B. J. N. asks how to remove stoppers in bottles. A. The best way is to take a turn round the neck with a stout string, hold the bottle firmly on the table with one hand, grasp one end of the string with the other, and get a friend to pull the other end. A little sawing will soon heat the neck sufficiently to expand it and loosen the stopper. I have extricated broken stoppers in this way, with nothing to lift them out by but a little bit of sealing wax melted into the broken surface. Try rubbing stopper with paraffin wax.

(9985) W. F. J. asks how to make waxed paper on a small scale. A. Place cartridge or other paper on a hot iron and rub it with beeswax, or brush on a solution of wax in turpentine. On a large scale it is prepared by opening a quire of paper flat upon a table, and rapidly ironing it with a heavy hot iron, against which is held a piece of wax, which, melting, runs down upon the paper and is absorbed by it. Any excess on the topmost layer readily penetrates to the lower ones. Such paper is useful for making waterproof and air-proof tubes, and for general wrapping purposes.

(9986) A. J. B. says: 1. What would be the force in pounds exerted at point A in Fig. 1, with the end of the rope fastened at point D and a force of 1,000 pounds pulling at point B, the other end of the rope? The direction of the two parts of the rope is such as to make the angles between A and D, A and B, and B and D 120 degrees each. A. The force exerted at point A is the resultant force of D and B, or 1,000 pounds. 2. Please explain the term "triangle of forces." A. If three forces acting at the same point balance each other, they are proportional to the sides of the triangle formed by any three straight lines parallel to their directions. Example: In triangle $A\,D\,C$ of Fig. 2 we have angle C equal to 90 degrees and angles A and D each equal to 45 degrees. Let side $A\,D$ or the hypotenuse of the triangle represent a force of 1,000 pounds. Then, by the use of the following rule the other two forces $A\,C$ and $D\,C$ can be found. Rule for right-angled triangles: The side opposite an acute angle equals the sine of that acute angle multiplied by the hypotenuse of the triangle.

Therefore $A\,C$ = sine of $D \times A\,D$,
and $D\,C$ = sine of $A \times A\,D$.

From table sine of A and D or 45 deg = 707. Therefore $A\,C$ and $D\,C$ = 707 pounds.

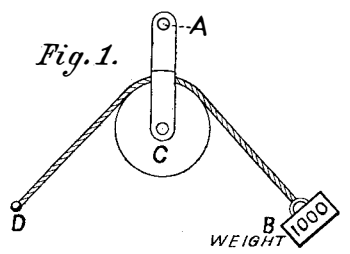

Fig. 1.

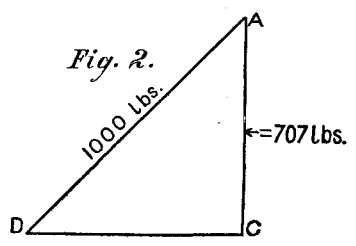

Fig. 2.

(9987) R. H. M. writes: Query No. 9966 in issue of May 12 asks why water pipes freeze when the surface of the ground is thawing. Although the phenomenon may not have come to your notice it is nevertheless quite common, as any plumber can testify. The explanation that has been made to me is the ice cream theory—the thawing ice above takes heat from what is below. Be this as it may, it seems to be a fact that water pipes freeze when it seems there ought to be no danger, and it is hard to convince the owner that freezing is the cause of the stoppage.

(9988) W. L. W. asks: Kindly advise me in your query column if you believe that any two things in the world are exactly alike. In a recent argument I took the stand that there were lots of things in the world just alike. My opponent took the stand that there were not; that there were no two grains of sand exactly alike, that there were not two nails or tacks or brads exactly alike in the world, and that even no two molecules which compose all the iron and steel in the world are exactly alike. It is probable that it is impossible to prove either assertion, but I will thank you for your opinion. A. We have no opinion whatever upon the question whether there are two things in the world exactly alike. We believe fully that a man can tell the same story twice in exactly the same way, and that the same old questions come up to us with startling similarity. Among these Wandering Jews which are ever young and always bobbing up serenely is the inquiry which you ask. What is the use of discussing such a quibble? Why not start a new and fresh *quid nunc?*

(9989) S. C. H. asks: 1. What is the meaning of "ampere hours"? A. An ampere hour is a current of one ampere flowing for one hour. This phrase is exactly the same in form as "horse-power hour" or one horse-power used for one hour. 2. How is the amperage of any light or coil measured? A. The amperes used by a light or coil are measured by an ammeter put into the circuit so that the current flows through it. 3. What are the necessary steps for a young man to get a position as electrician on board an ocean liner? A. To become an electrician in any position, learn the business thoroughly and then apply for the place you want. Make it appear that you are the man for the place, and you will be likely to get it.

(9990) C. A. C. asks: Will you inform me about the specific gravity of liquid fluorine? A. Hardin in "The Liquefaction of Gases" gives the density of liquid fluorine at 1.14. This must be considered an approximation more or less close, from the manner in which it was obtained. We can send you the book for $1.50.

NEW BOOKS, ETC.

THE DYNAMICS OF LIVING MATTER. By Jacques Loeb. The Columbia University Press, 1906. 8vo.; pp. 233. Price, $3.

Dr. Loeb's book is undoubtedly one of the most important contributions to the literature of biology which has been issued for some time. It is based on a series of eight lectures delivered at Columbia University in the spring of 1902, which were intended to present the author's researches on the dynamics of living matter, and the views and theories to which these had led him. In the preparation of the book the lectures were supplemented to give a somewhat more complete survey of the field of experimental biology, but still without altering their character. Dr. Loeb considers living organisms as mere chemical machines which possess peculiarities of automatically developing, preserving, and reproducing themselves. This opinion, given at the very beginning of the first lecture, strikes the keynote upon which the succeeding ones are constructed. He considers that the fundamental difference between living machines and artificial machines is the fact that the latter, which can be created by man, do not possess the power of automatic development, preservation, and reproduction; but he declares that nothing contradicts the possibility that the artificial production of living matter may one day be accomplished, for living organisms are doubtless nothing more than chemical machines. Dr. Loeb's book is of undoubted interest, and not only the biologist, but the unscientific reader as well, will find in its pages much fascinating information.

A POCKET-BOOK OF MECHANICAL ENGINEERING. Tables, Data, Formulas, Theory, and Examples for Engineers and Students. By Charles M. Sames, B.Sc. 4 x 6⅝ inches; pp. 168; 38 figures. Price, $1.50.

While there are many excellent engineering handbooks before the public, the practical engineer as well as the theorist will find this work a concise, comprehensive, and up-to-date compilation of mechanical engineering information. The book is well indexed, and the contents are so classified that reference to any subject may be made at a minimum of effort; it may be conveniently carried in the pocket under all circumstances. The chapter dealing with reinforced concrete is especially recommended.

AMERICAN SHOEMAKING DIRECTORY FOR 1906. A List of Shoe Manufacturers of the United States and Canada. Giving the classes of goods manufactured, the trade for which they manufacture, names of buyers and superintendents, capacity of factory, number employed in leading factories, alphabetical list of manufacturers, Boston offices, location of towns, population, railroads, express companies, etc. Revised to April 1, 1906. Boston: Issued from the office of American Shoemaking. Paper or flexible leather. Price, $1 or $2.

A NEW AND PHYSIOLOGIC EXPLANATION OF A COMMON PSYCHOLOGIC PHENOMENON. By F. Park Lewis, M.D. Chicago: Press of the American Medical Association, 1906.

BREEDING PLANTS AND ANIMALS. By W. M. Hays. Minneapolis: The University Press, 1906. 12mo.; pp. 189.

During the last few years many novel theories have been evolved relating to the problems of breeding both animals and plants. The work of Luther Burbank has revealed extraordinary possibilities in horticultural development, and the working out of systematic methods of breeding and of disseminating the various field crops at the Minnesota experimental station, has attracted wide attention in scientific circles. In this work Prof. Hays, Assistant Secretary of Agriculture, has put in book form the latest ideas regarding the breeding of animals and plants, including the work of leading authorities as well as the results of his own extensive experiments. The book describes comprehensive plans for the improvement in varieties of field crops, and includes chapters on breeding cattle, horses, and other animals for specific purposes.

THE PRIMORDIAL ENERGY. By Benjamin W. Sands. Springfield, 1906. Pp. 18.

This extremely interesting pamphlet is based upon a lecture delivered by the author in 1905, after nearly ten years spent in study and experiment to determine the truth or falsity of the new discoveries set forth. He has proven, to his own satisfaction at least, that all the various kinds of energy are but different phases of magnetic vibrations, which he declares to be the primordial force of nature. The two illustrations of photographs made by magnetism and by means of ozone interestingly supplement the text, which largely discusses radiant energy in various forms.

PRACTICAL GUIDE FOR FIREMEN. By W. H. Wakeman. New Haven, Conn.: Published by the Author, 1906. 16mo.; pp. 93. Price, 50 cents.

The intention of this little work is shown in its title. It is practical and concise, and describes in word and illustration many points of interest and value to the man in the engine room. The style is well calculated to make the instruction interesting, while the Appendix contains information which will assist in obviating many troublesome situations often encountered by firemen and engineers. The two hundred examination questions included will be found useful in many ways.

THE UNIVERSAL KINSHIP. By J. Howard Moore. Chicago: Charles H. Kerr & Co., 1906. 8vo.; pp. 329. Price, $1.

By this title the author indicates the purpose of the book, which is to prove the kinship of all the inhabitants on the planet Earth, from the lowest protozoa to the highest animal, man.

Nor does Mr. Moore limit this kinship to the physical, but he declares it to be an ethical one as well. The thesis of the book is undoubtedly *contra* to many existing theories, and will prove interesting to readers for this reason, as well as for the undoubted originality shown in many phases of the discussion, though the author's opinion of his fellowman is rather more hopeful for the future than optimistic concerning the present.

SLICES FROM A LONG LOAF. By H. C. Stiefel, Ph.D. Pittsburg: Bissell Block Publishing Company. 8vo.; pp. 221.

It is seldom that a book which proposes, even in a measure, to discuss scientific, industrial, or manufacturing subjects can be as entertaining as this one by Dr. Stiefel. It is the account of a voyage of five Pittsburg tourists down the beautiful Allegheny River from Oil City to Pittsburg, and it tells many things that happened during the expedition, humorous and otherwise, and gives in facts and figures reasons for Pittsburg's greatness. Of the illustrations, which are from photographs and drawings, many are exceedingly humorous, while others illustrate numerous phases of the iron, coal, and oil industries. The reader will find much truth and some fiction in the book which, beginning with the author's humorous preface to the *finis* on the last page, is thoroughly entertaining.

MODERN MATERIA MEDICA. New York: The Druggists Circular, 1906. 12mo.; pp. 306. Price, $1.50.

This book is intended to supply the evident need of some work of ready information concerning the many new additions to the materia medica. It embraces all the newer remedies introduced up to the beginning of the present year, including the nutritives which are replacing a great many stimulating medicines in the treatment of certain maladies and in convalescence. The information given is complete, concise, and accurate, and the user will probably find it unbiased. It is expected that this work will take a place next to the Pharmacopœia and the National Formulary, and will fill a long existing want in the library of the practical and up-to-date pharmacist.

ENIGMAS OF PSYCHICAL RESEARCH. By James H. Hyslop, Ph.D., LL.D. Boston: Herbert B. Turner & Co., 1906. 12mo. Price, $1.50.

In this volume Prof. Hyslop, an undoubted authority on the subject, discusses that phase of psychical research which may be classified as super-normal. Certain chapters are devoted to the history of psychical phenomena, to crystal gazing, telepathy, mediumistic phenomena, apparitions, and other manifestations of like nature. The author interestingly illustrates each subject by many examples taken from cases carefully investigated by that responsible and eminent group of scientists composing the Council of the Society for Psychical Research. The book will be of interest to those who wish to keep themselves well informed in this fascinating if little understood subject, and many readers will doubtless appreciate the value of scientific knowledge of this character, which assures us of a future life, if only as a plea for social morality. Dr. Hyslop's discussion is earnest and judicious, and is undoubtedly free from dogmatism and propagandism.

ELEMENTARY ELECTRICAL ENGINEERING IN THEORY AND PRACTICE. By J. H. Alexander, M.B., A.I.E.E. New York: D. Van Nostrand Company, 1906. 12mo.; pp. 208. Price, $2.

This eminently practical little volume is based on a series of lectures delivered by the author before a class composed chiefly of young artisans, and it is intended rather to present fundamental principles and practical applications of the same than to enter into theoretical and involved discussion. The lectures were illustrated by means of models, apparatus, lantern slides, and blackboard diagrams, etc., and these were, of course, unavailable for the purpose of the book. The illustrations, which were carefully gotten up to take the place of these, are clear and answer the purpose excellently. All complicated mathematical formulæ, which might tend to confuse beginners or those not fully familiar with mathematics, have been omitted, but many of the chapters include exercises worked out at full length, which will undoubtedly be of assistance to the student in illustrating the character of the problems to be met in practice.

NORDAMERIKANISCHE EISENBAHNEN. By W. Hoff and F. Schwabach. Berlin: Verlag von Julius Springer, 1906. 8vo.; pp. 377. Price, $2.50.

Unfortunately for American readers, this book, which appears to be one of the best of foreign observations regarding American railroads that has recently been published, is printed in German, and it is to be hoped that its translation will not be long delayed. The authors have treated their subject at considerable length, with clearness, with no mistaken ideas of fact, and with fairness. The subject of American railroads, always a difficult one not alone from its vastness, but from the variety of interests involved, has been ever an interesting one for European investigators, and it was in the interests of the German railroad world and under the auspices of the Prussian Ministry of Public Works that this extensive tour of investigation was undertaken. The authors, on the whole, appear to have been favorably impressed with many of the obtaining transportation conditions, though by no means blinded to the faults and disadvantages with which many Americans are familiar. They wisely make allowance for differences arising from capitalization, rail and express service, freight rates, express companies, etc., and draw the general conclusion that the Prussian rates, both passenger and freight, are somewhat lower than those in this country. It must be agreed that this is far and away the most thorough comparison that has ever been made between the railway in the United States and a foreign railway system—that of Prussia. To the German reader the chief value of the report probably lies in the excellent objective description of railway organization and management in this country. To the American reader the value lies in the comparisons the report contains.

THE BOOK OF BOATS. A Brief Story of Some of the Queer Prototypes of the Modern Launch. By Raymond Cavanagh. St. Paul, Minn.; Randall Printing Company, 1906. 16mo.; pp. 123.

The author of this interesting booklet discusses water navigation by means of small craft from its earliest inception, as exemplified by the crude raft of prehistoric man, to the present day, represented by our latest types of high-speed motor craft. The evolution of the boat with the ethnological development of man is described and illustrated in its most interesting phases. The illustrations show many remarkable and curious vessels designed and constructed by savage builders the world over, and are the result of exhaustive investigations in the literature of the subject as well as in the various museums. The last chapter discusses modern types of pleasure craft, and illustrates several types of motor boats.

THE ART OF WRITING AND SPEAKING THE ENGLISH LANGUAGE. Word Study, Grammar, Composition, and Rhetoric. By Sherwin Cody. New York: The Old Greek Press, 1906. 32mo. Price, $3.

As the title of this work indicates, the author has chosen a rather ambitious subject; for if there is a subject of really universal interest and utility, it is the art of writing and speaking one's own language effectively. Not only is it the basis of culture, but it undoubtedly is the basis of business as well, and in no department of human endeavor is the value of effective English to be more highly rated. These four little books, "Word Study," "Grammar," "Composition," and "Rhetoric," are written particularly with the adaptation of good English to business in view, notwithstanding that they would be of unquestionable value to the student of English in general. The subject is treated clearly and without waste of space, and the facts are presented to the reader in an excellent manner.

WIRELESS TELEGRAPHY. By Gustav Eichhorn, Ph.D. Philadelphia, Pa.: J. B. Lippincott Co., 1906. 8vo.; pp. 110.; 79 illustrations.

Notwithstanding the many excellent contributions to the literature of wireless telegraphy that are at present before the public, there are many phases of the theoretical as well as the practical side of this interesting subject which are necessarily somewhat obscure. The author of this book has wisely not attempted to make it a compilation of the many so-called "systems" of wireless telegraphy, but has devoted his efforts to a simple and comprehensive description of the fundamental principles and working methods of modern telegraphy by means of electric waves. Consequently the work will be found of value not only by the student, but by the practical expert as well. For the latter, particularly, is the wide experience of the author valuable. The book is excellently illustrated with many engravings and diagrams, and probably brings the literature of the subject as nearly up to date as is consistent with its rapid growth.

NATIVE ECONOMIC PLANTS OF MONTANA. By J. W. Blankinship. Bozeman, Montana: Montana Agricultural College Experiment Station, 1905. 8vo.; pp. 36.

INDEX OF INVENTIONS

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AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

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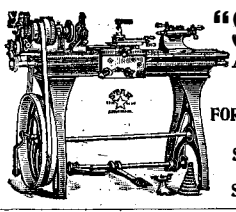

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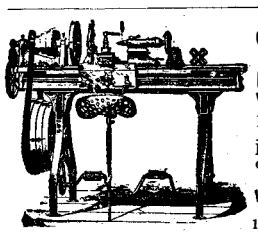

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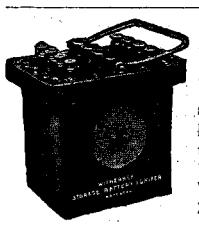

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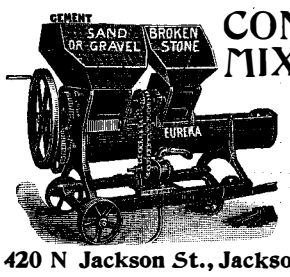

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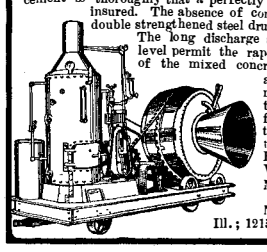

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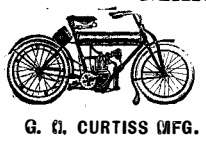

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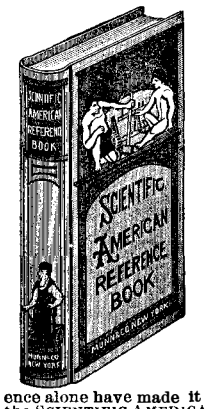

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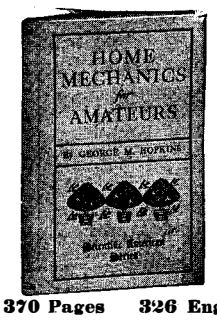

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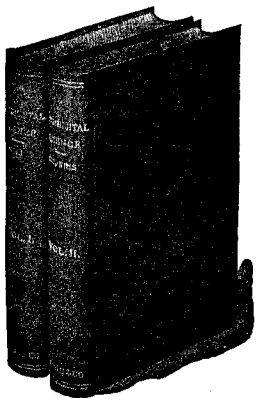

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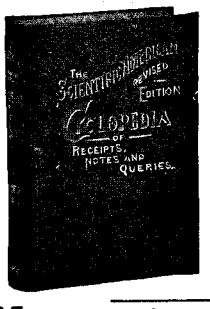

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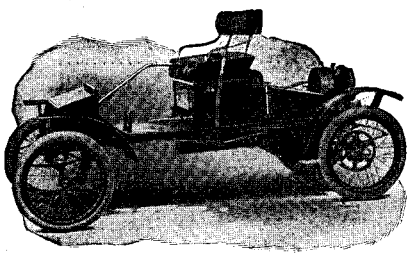

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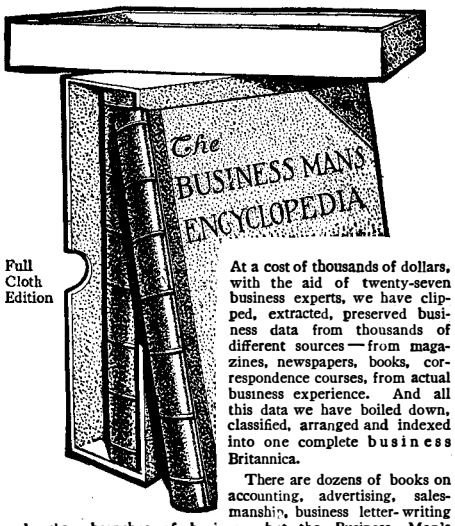

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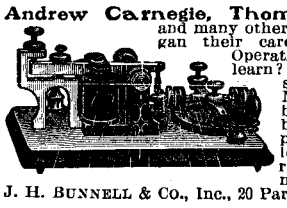

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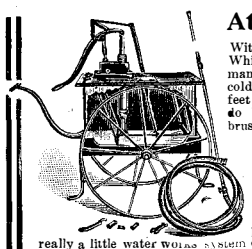

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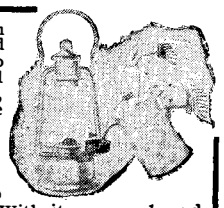

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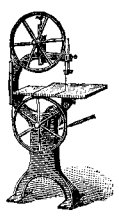

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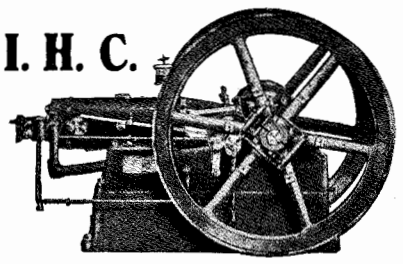

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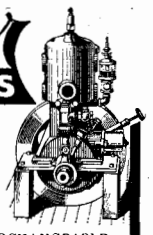

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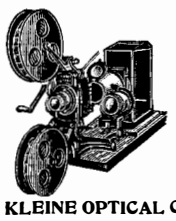

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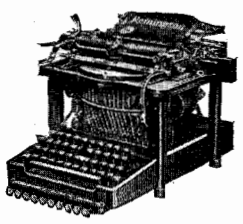

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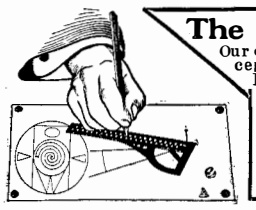

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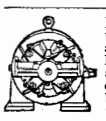

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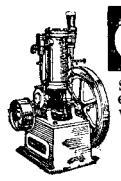

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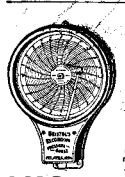

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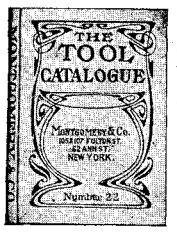

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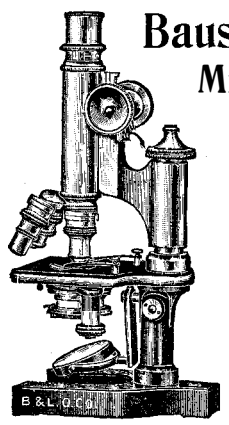

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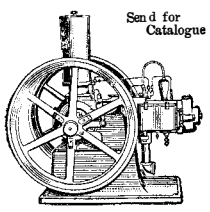

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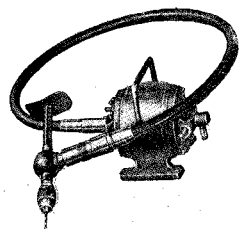

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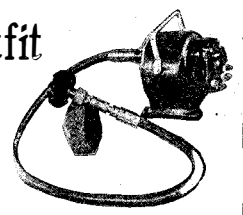

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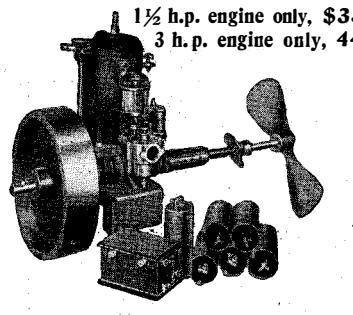

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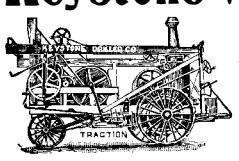

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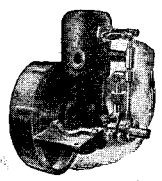

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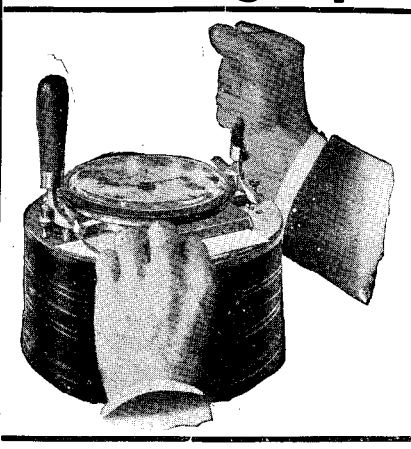

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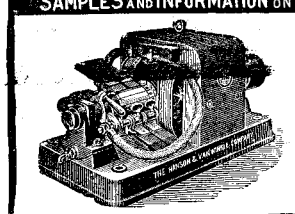

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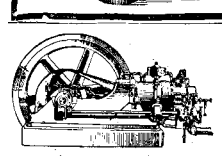

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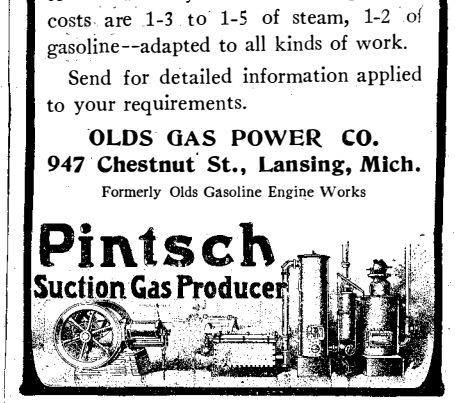

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